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DRAWINGS OF MARS.

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(Secretary of the Lowell Observatory.)

FOR POPULAR ASTRONOMY

In August, 1896, I had my first view of the planet Mars, at the Lowell Observatory, at Flagstaff, and by the side of the late Alvan G. Clark who made the glass I was then looking through. He said to me by way of encouragement for the 'seeing' was not good—"You must not look *at* it but *on* it." At first I did not appreciate his remark but as I sat there and began to concentrate and observe more minutely I felt what he meant. I saw that Mars had a decided expression and that it did not look like a flat reddish disk as my first glance showed. The South cap and shadings through the central portion of the planet were quite evident and I came away much gratified though I had seen no canals.

From time to time during that opposition I had many looks and each time saw more. I made no records, however, till in Mexico toward the end of the opposition. In 1901 I continued my observations at Flagstaff and again in 1903 and 1905. Drawings from the two last oppositions are here presented with a few brief notes.

Notes: The following notes were written at the time the drawings were made and the numeral at the side denotes the drawing to which they refer, the drawings being numbered successively on the Plates. Many times the seeing was so good that in my excitement at picture-making I forgot to take notes on the multiplicity of detail.

1903

I	Apr. 22,	9h -50m-10h	power 310	seeing 8	
II	May 5,	7h -10m-25m	" 310	" 7-8	
III	" 18,	7h -20m-30m	" 310		
IV	" 18,	9h -45m-10h n.g* (12 in. diaph.)	" 310	" 6	
V	" 19,	6h -55m-7h-7m	" 310	" 5-7	

* n.g. A screen of neutral glass having a better effect even than a monchromatic one.

1903

VI May 23, 7h –20m–30m power 310 seeing 5-6 (at glimpses)

VII " 23, 9h –45m–50m (12 in. diaph.) " 310 " 4-5

VIII " 24, 6h –40m–50m " 310 " 6

IX " 26, 7h –36m–45m " 310 " 5-7
Saw projection on the terminator of Mars at 8:45 (observed first by Mr. V.M. Slipher.) Large and separated from the planet by a band of black.

X June 26, 7h –20m–30m power 224 seeing 5-6

XI " 27, 6h –50m–55m " 6
7h –20m–25m glimpses 8

XII " 28, 7h and at intervals till 7h–45m power 310, seeing 8-9. Never saw such seeing. I marked it 8-9; image absolutely steady and definition almost perfect. Could it be better? One of the finest sights of my life.
I think I glimpsed the *Astaboras* once though I have not drawn it. It was not quite clear to me at what point the *Phison* ended. The S W. north cap (?) very white.

XIII " 30, 6h –20m–25m and 40m–45m

XIV July 1, 6h – 6h –05m " 224 " 5-6

XV " 1, 6h –35m–41m " 310 " 6-7

XVI " 2, 6h –10m–16m " " 3-4

XVII " 2, 6h –40m–45m " " 5
At 6h–45m saw the *Phison* better than I have ever seen it before. Double, indeed.

XVIII " 3, 6h- 45m–50m and 7h–05m–10m " 5+
Very white along *Aeria*-coast-line. Suspected the *Euphrates*.

1905

XIX June 1, 10h –6m–15m " 6
The seeing *was* good; disk very steady.

XX " 9, 9h –40m–45m (12. in diaph.) " 493 " 4-5

XXI " 9, 10h –10m–15m " 310 " 5
Oxus added to my drawing of 10h–10m some little time after—about 10h–40m, I should say.

XXII " 11, 9h –50m (about) (12 inch. diaph.) " 544 " 4

XXIII " 11, 10h–about n.g. " 544 " -54
The *Euphrates* looked as I cannot draw it. It was heavy on the right and as if its shadow showed on the left of it.

XXIV " 12, 8h –40m–05m " 5
Suspect canal going out from bulge in right of Syrtis.

XXV " 13, 8h –10m–7m (18-in. diaph.) " 544 " 6

1905

XXV June 13, 8h -10m-7m (18-in. diaph.) power 544 seeing 6
Lower Syrtis is a dark ocean blue and upper or Mare Cimmerium a gray-green at first; later drab.

XXVI " 13, 10h -25m-30m " 6

XXVII " 14, 8h -30m–about. n.g. " 544 " 4

XXVIII " 15, 8h -35m-42m (12 in. diaph.) " 490 " 3-4?

XXIX " 16, 8h -30m n.g. " 310 " 3-4
Dotted lines either side of Syrtis indicate brightness.

XXX " 17, 7h -55m-08m

XXXI " 18, 7h -05m " 270 " 4

XXXII No record.

XXXIII " 19, 7h -50m-55m and 8h–05m–10m " 310 " 6

XXXIV " 20, 7h -30m (18 in. apr.) and 7h -40m-45 " 3-4

XXXV " 20, 8h -28m-33m " 5

XXXVI " 21, 7h -45m-50m " 310 " 3

XXXVII " 21, 8h -10m–about n.g. " 310 " 4-5

XXXVIII July 8, 7h (18 in. apr.) " 270 " 3

XXXIX " 8, 7h -19m-24m

XL " 9, Observed Mars but was interrupted and did not make a drawing till three hours later from memory. Positions not at all certain.

XLI " 10, 7h -20m-27m, clouds. " 5

XLII " 13, 7h -28m-33m and 7h -50m–about " 270 " 6
Looked at 8h-05m and thought to verify former drawing (7h-28m-33m.) This is a copy but doubt if it is any better.

XLIII " 14, 6h -10m-18m " 6

XLIV " 14, 6h -30m-34m " 6

XLV " 15, 6h -30m-40m " 270 " 4

XLVI " 15, 6h -56m?-7h-04m n.g. " 270 ,, 4-5
Queer birth-mark effect on left side of planet as I have drawn it—shaded.

XLVII " 16, 6h 30m–about " 5

XLVIII " 16, 6h -35m-39m n.g. " 270 " 6-7
Thought to glimpse beginning of Mr. Lowell's newly discovered canal but am not certain of it.

XLIX " 17, 6h-35m-40m(18in.diaph.)"270 ,, 5

L " 18, Observed at intervals from 6h-45m to 7h -30.m Seeing varied from 2 to 4 to 5 at glimpses, mostly 3. The most striking thing to-night is the color. Beautiful rosy

orange! Very sure of *Euphrates*; glimpsed *Phison*.

LI July 19, 9h -10m-20m (12 in apr.) seeing 3
Fleeting glimpses through clouds. Saw the *Sitacus* as if it were a line suspended in the air for a glimpse only.

LII " 20, 7h -10m-16m " 4-5

LIII " 21, 6h -50m-57m power 270, 310 " 3-4
Mare Erythraeum very pale in tone. Apex of Syrtis very dark.

LIV Aug. 12, 5h -15m-20m " 4-5

LV " 12, 6h -45m-50m " 4-5

LVI " 13, 7h -20m-25m " 310 " 5
(18 in. diaph.)

LVII No records.

LVIII " 14, 7h -20m-30m " 310
My last night at Flagstaff (of this opposition) and though very tired I think I saw pretty well. The Hydraotes was plain to me, also other detail came out distinctly.

June 30, 1907.
Flagstaff, Arizona.

THE SPARSITY OF THE STARS—THE MEASURELESS REMOTENESS OF EACH STAR FROM ALL OTHERS.

J. F. LANNEAU.

For Popular Astronomy.

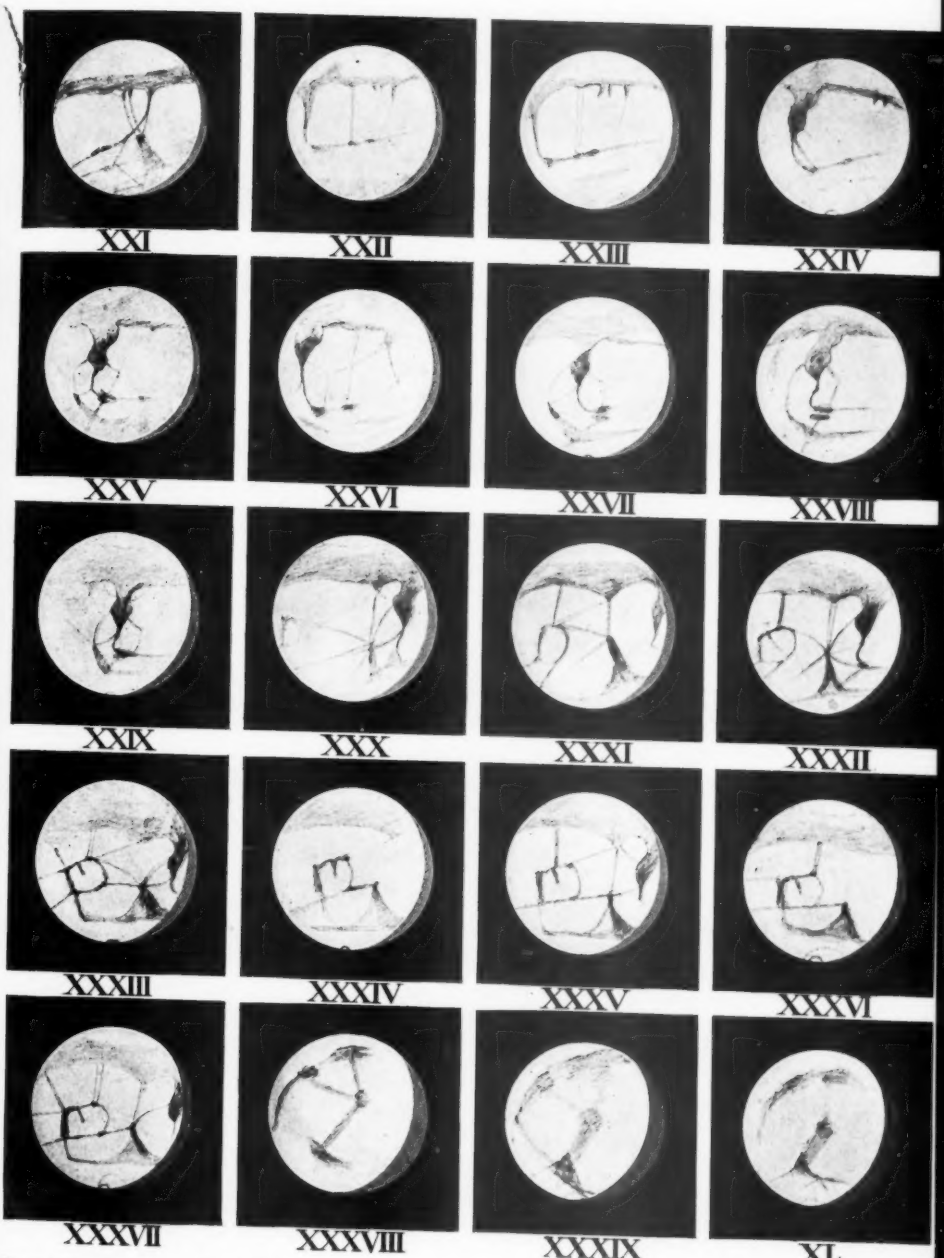
In February 1901 there suddenly appeared in the northern sky a previously unseen star about as bright as the familiar Pole star. It quickly brightened, and in less than three days vied with Sirius, the brightest of the stars. Then, fading rapidly for a month, it resumed its former invisibility.

I cite it only to illustrate stellar distances. The sudden blazing up of that star to a 25,000-fold brightness, really occurred over three centuries ago—occurred before Jamestown's settlement, whose tercentennial is now being celebrated.

Such that star's distance, that its light flashing from its unthinkable remoteness had just reached us in February 1901!

Up above the world *so* high,
Like a diamond in the sky,
Twinkle, twinkle little star,
How I wonder what you are!

PLATE IX.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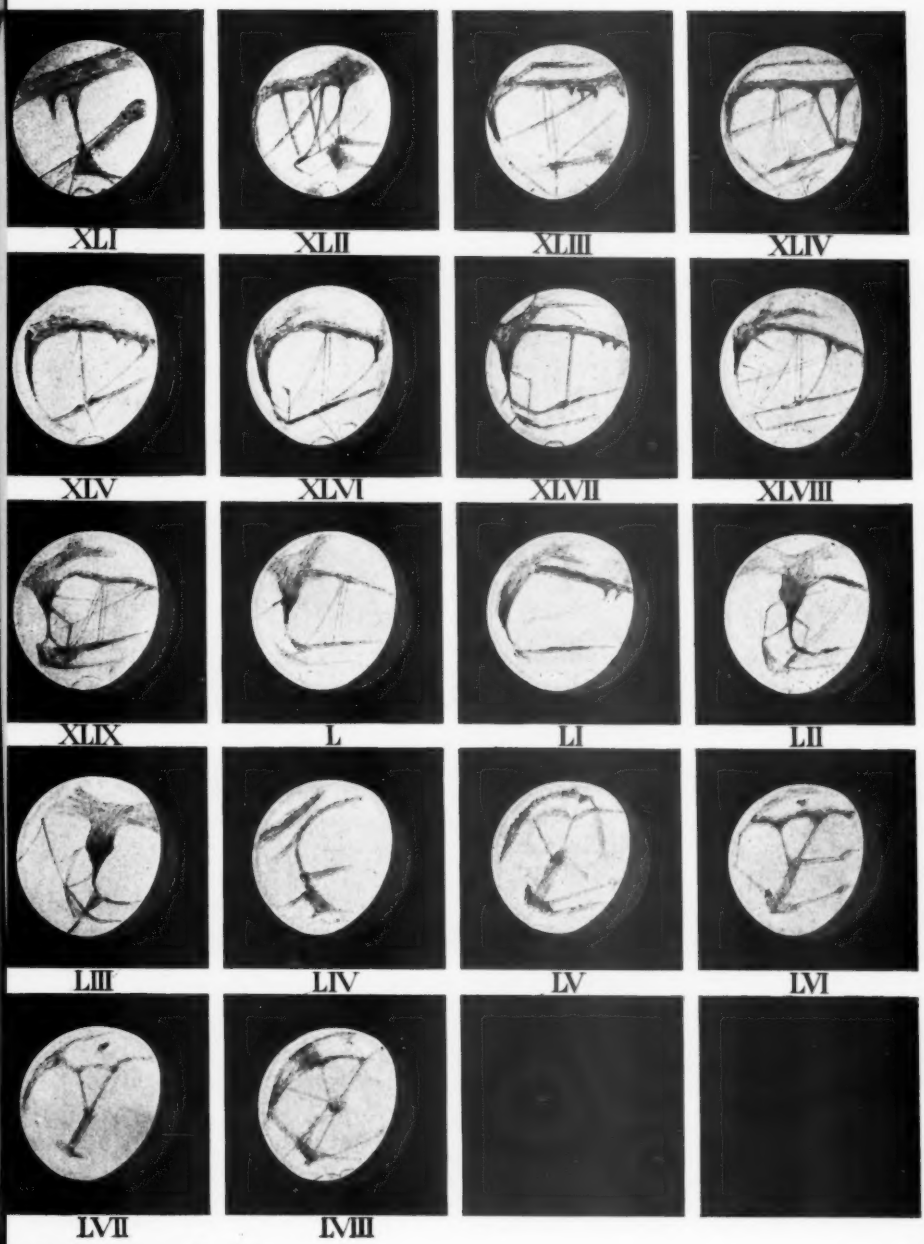
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This, the child's simple questioning, seems to voice an inborn longing of mankind. From time immemorial the sky's glittering finger-marks of Deity have attracted man's untiring attention.

When the jeweled brow of night is contemplated perhaps the first question it provokes is:

ARE THE STARS INNUMERABLE?

Most of us think we see a countless multitude. But contrary to this popular impression, the visible stars are really quite limited in number. They have been mapped accurately, carefully counted and found to be, all told, less than 7000!

Of course the telescope brings into view millions more—a countless host. But even from a favorable standpoint on the Earth's equator, scanning the evening sky from pole to pole throughout the year as its twinkling lights pass in review, you cannot count as many as 7000 stars.

Of the half of them above you in the sky any night some 1500 will be concealed by the murky air all around your horizon. At no time as you patiently scan the glittering sky do you see more than 2000 stars.

HOW FAR OFF ARE THE STARS?

Too far to state in miles. To name the distance to the nearest star in miles, would be like stating the distance to the Moon in inches. For stellar remoteness we need a large unit—not less than the distance from the Earth to the Sun. Some hundreds of thousands of this long unit express somewhat intelligibly the star's distance from us—provided the unit distance is comprehended.

Unfortunately any mental picture of this earth-sun unit distance must be inadequate. We may aid imagination however, by noting the time of transit of some missile or swift vehicle.

A balloon soaring sunward may aid conception. Assume that Columbus in the year 1492, to signalize his discovery of America, had sent up a balloon to the overhead Sun; and suppose that, regardless of failing atmosphere, it rose swiftly, steadily 37⅓ miles every hour until it reached the Sun. When did it reach its destination?

Columbus retraced his uncertain course across the broad Atlantic, presenting the new-found western continent to Ferdinand and Isabella. He made other long voyages—other discoveries. Still the balloon was swiftly mounting sunward! More than a century passed. Jamestown was settled. Virginia's forest witnessed the romance of Pocahontas. The Mayflower landed at Plymouth Rock; and later, New England nestled in the wilder-

ness. Still the balloon was mounting! Long Indian wars were waged. Colony after colony struggled successfully into civic strength—thirteen of them. Old England misruled. Edenton harbor and Boston harbor were tea-tinctured.

Lexington's guns heralded a new flag—the stars and stripes. Independence was declared. Then, late in the new nation's natal year, the balloon which had mounted steadily sunward 37⅓ miles every hour for wellnigh three centuries had just reached the Sun!

Its long flight measured our needed unit of distance—the stretch from Earth to Sun—a swift balloon's three centuries climb!

275,000 times this unit is the distance to the nearest star—the bright southern star Alpha Centauri.

That nearest of the stars is more than a fourth of a million times farther from us than the Sun is.

No balloon will help thought across that nearest star's long reach. Will the swiftest known vehicle, an automobile, aid us?

In January 1906 one of these marvels of speed raced on Ormond Beach, Florida, at the rate of 128 miles an hour. Suppose it could speed to the stars, going steadily 120 miles an hour—two miles a minute—for days, years, centuries. It would reach the nearest star in something more than 24 million years!

Two miles a minute for that many million years—240 thousand centuries—will not quite span the unthinkable distance to the nearest twinkling star.

What then the distance to the stars beyond? What the distance to those so remote in the depths of space that powerful telescopes bring them only faintly into view?

For these stupendous distances our earth-sun unit—the 93 million mile unit—is too short, automobile speed too slow. For these staggering stellar reaches through boundless space, a special new unit of length must be devised. It is called the light-year—meaning the distance light flashes in a year.

We must realize if possible, something of the significance of this unit—the distance light goes in a year.

The first creation from primal chaos was light. "Let light be, and light was." It moves with the swiftest speed known. Its unrivalled velocity—first learned in 1675 by noting eclipses of Jupiter's moons, more recently proved experimentally—is 186,330 miles per second!

This amazing distance through which light moves in one second, 186,330 miles, is over seven times the distance around the world. If a light ray instead of moving as it does in a straight

line could trace a circle, it would flash seven times around the world in a second! Yet, at its unrivalled rate, light in one year traverses less than a fourth of the distance to the nearest star.

Our two mile a minute automobile returning from that star would reach us, you will recall, in 240,000 centuries. A beam of its light comes to us in something over four years! In a word, Alpha Centauri's distance from us is over four light-years.

Sirius, the brightest of the stars, is eight light-years from us; Arcturus, twenty-four light-years; and Polaris, the familiar north star, is sixty light-years distant.

Some of the stars just visible to the unaided eye, are more than three hundred light-years distant from us. Many of those which are faintly seen through a large telescope are three thousand light-years off; and others are at distances of many thousand light-years!

With this insight into the vastness of stellar reaches— this suggestion of the stupendous scale of the sidereal universe—we may in some degree apprehend the otherwise astounding fact that any two visible stars, though seemingly side by side in the sky, are in reality distant from each other several light-years!

True, in many instances an apparently single star consists of two or more comparatively not far apart. But such systems are as isolated as are solitary stars. Regarding them as single stars it follows that despite appearances

THE STARS ARE NOT CROWDED.

They are remotely separated, widely scattered. Their seeming nearness to each other is but the effect of distance.

Looking down a long straight stretch of railroad the rails on either side, though always equally wide apart, apparently converge to a point. In the distance they seem to touch each other. Two mountain peaks which in reality are several miles apart, when seen in the distance appear side by side, may seemingly touch.

So with the inconceivably distant stars. Closely grouped apparently, as in Perseus or Scorpio or in any of the constellations, no two stars are really neighbors. Any two of them, on the average, are twice as far apart as are the Earth and the nearest star.

A fast automobile run—two miles a minute—from star to nearest star would take, as from Earth to star, not less than 240,000 centuries; more likely, a half million centuries!

Often the two apparent companions are nearly in the line of sight—one far beyond the other. For instance, in the northern

constellation Cassiopeia are two faint stars, Eta and Mu, seemingly side by side; one is distant from us 21 light-years; the other; 9 light-years. The two, then, seemingly close neighbors, are in reality separated a distance of at least 12 light-years—about three times our distance from the star Alpha Centauri.

The familiar Big Dipper is outlined by seven stars: three in a curve trace its handle, and four its bowl—the two farthest from the handle pointing to the Northstar.

Could you stand on any one of the seven stars in that group, the nearest of the others would appear to you about as the star Sirius appears to us! So stupendous is the scale of the stellar universe—so widely scattered is the sky's twinkling host!

Are the stars motionless?

We speak of the "fixed" stars in contradistinction to the planets. For planetary motions, like that of our Earth around the Sun, are made manifest by the seemingly stationary stars far beyond in the depths of space.

But the stars are not even relatively fixed. Centuries ago, Job spoke of Mazaroth in his season, of Arcturus and his sons, of the sweet influences of the Pleiades, of the bands of Orion. He saw the Dipper's handle pointing to Arcturus, the Pleiades close to the Hyades, Orion's belt above his sword—just as we now see them.

Mazaroth and other groups—the Dragon intruded between the Dippers, its head under the foot of Hercules; the Sea Monster seeking fair Andromeda, and barred by Perseus bearing the Gorgon's Head; the Cross in Cygnus, the Archer, the Arrow, the Eagle—all of the constellations, appear to us now as they appeared to earliest man.

Nevertheless, the stars are not fixed. They are in motion, and in all directions; each in its independent course in straight, swift, steady motion. They are certainly changing their relative positions.

Why then are the changes not perceived? Simply because of what has been noted—their inconceivable distances from us and from each other.

One effect of great distance is to mask motion. I cite a notable terrestrial instance. From Mitchell's Pass, the highest railroad crossing of the Rocky Mountains, 18,000 feet above sea-level, one looks down the steep curving spurs and slopes towards the Pacific for hundreds of miles. He sees in the far distance, at intervals, train after train, east-bound and west-bound. He knows that each of those hurrying trains is making at least a

half-mile a minute. Yet, in the distance, they seem to stand still!

So with the twinkling stars in the far away depths of space. Moving in straight paths, in all directions, each is speeding not half-miles per minute, but miles per second. Yet, so great is their remoteness they seem to be quite stationary—even relatively unchanged.

But the incontestable proof of their real, though to us imperceptible change, is found in comparing star charts made long centuries ago with charts recently made.

For instance, the bright star Sirius mapped by Ptolemy seventeen centuries ago, is shown by modern charts to have moved southward about the apparent breadth of the full Moon.

A moon-breadth in seventeen centuries! Yes, but a moon-breadth at our Moon's distance is two thousand miles; at our Sun's distance, nearly a million miles; and at Sirius' distance, a moon-breadth is hundreds of thousands of millions of miles!

What are the stars?

Viewed through a telescope a star seems to be a mere point of light. The larger the telescope, the more of the star's light entering its great eye, the brighter the star's image, but the image is still a point.

The star's really vast volume, millions-fold larger than this Earth, seemingly shrinks to a mere bright speck because of its inexpressible remoteness from us.

How can it so shine from the profound depths of space? Does it receive light from the Sun and reflect that light to us as do the planets? Is the star's light only reflected sunlight?

Polariscope and spectroscope both ring out No, an emphatic No. Starlight is not borrowed sunlight. Each star, as the subtile spectroscope proves, shines by its own energy, is self-luminous—is itself a Sun!

Our resplendent Sun and those remote twinkling stars reveal under spectroscopic ken the same essential structure. Each star is indeed an immense glowing body, dispensing freely its own heat and light.

Some of them—notably Canopus and Arcturus—are vaster in volume than our immense Sun, and more gloriously effulgent. Could our Sun withdraw from us and retreat into the depths of space, on its way to one of those remote giant stars it would itself become a twinkling star—and farther on it would look fainter and fainter until invisible.

An obvious question arises: is our Sun, like each of the other stars, speeding through space in a definite straight course? Yes,

like the distant twinkling suns our Sun is speeding, we with it are speeding through space starward.

What the evidence? Herschel's patient scrutiny, comparing the star charts of Hipparchus, Ptolemy, Ulugh Beigh and Tycho Brahe, made centuries apart, discovered that the stars in the region of the constellation Hercules appear wider apart than formerly—and that those in the sky opposite about Orion, appear nearer together.

Compare this fact with the familiar one that far off trees as you approach them appear wider apart, while the trees behind you in the distance close together.

Thus it is seen that our solar system, Sun and planets, is speeding towards Hercules—or more nearly, towards the bright star Vega, now conspicuous in the northeast.

The spectroscope confirms this fact. Moreover, it shows that our Sun's steady motion toward Vega is at the rate of some twelve miles a second.

In a year, we move in that direction four times the earth-sun distance; as far as our two-mile a minute automobile could travel in over three centuries.

Do you ask, when will we reach the star Vega? In some four thousand centuries we will reach Vega's present region of space—but not Vega. Its motion meanwhile will have borne it to new remoteness.

We will then be where it now is. We will have indeed a new pole-star, but will still see in the north the same Big Dipper—a little bent doubtless—and will see the same Galaxy, the same Zodiac, the same glittering constellations from that view-point then as from this one now.

Speed on towards Vega, and on and on; the myriad stars—ever distant, each in rapid independent motion; because of their always stupendous remoteness from us and from each other seemingly unchanged—will all the while present still their old familiar groupings.

That since the "Beginning" we, with our Day-Star, the Sun, have been steadily speeding on and on through interstellar space without once meeting or passing a single lonely star, brings home to our realization as no other consideration can, the amazing amplitude of cosmic space, the completeness of the isolation of each star from all others, the supreme magnificence of the SCALE of the stellar universe; a magnificence worthy of man's Creator—who "made the stars also, the work of his fingers."

Wake Forest, N. C.

THE EARTH BEFORE THE EARTH-MOON CATASTROPHE.

G. D. SWEZEY.

For Popular Astronomy.

In a recent number of Popular Astronomy Professor W. H. Pickering has discussed the interesting question whether we can discover on the Earth's surface the place from which, in accordance with the theory of Tidal Evolution, the Moon was torn away; and he concludes that the basin of the Pacific Ocean is the scar left by the great earth-moon catastrophe which the theory assumes, and that the Atlantic Basin is a rift formed by the tearing asunder of the remainder of the floating crust, to form the Eastern and Western Continents.

The rearrangement of the continents which he suggests leaves however a large area in the western Atlantic, as well as the Mediterranean Sea, not well accounted for. Now if such a catastrophe occurred as the sloughing off of the major part of the Earth's crust and the rending asunder of the remaining part, it is very unlikely that the fragments thus left behind would have retained their original arrangement. North America, South America, Africa and the smaller land masses are now almost completely surrounded each by deep ocean basins; the connection

of North with South America and of Africa with Euro-Asia is very slight; it would be more than likely not merely that South America might be swung around, as Professor Pickering suggests, into a slightly different alignment but that a considerable readjustment of any or all of the continents might take place. If we are at liberty to assume at all such a great continental rupture as he suggests, it would seem to be in order to study the shapes of the several continental masses with a view to such a rearrangement as would make them best fit together.

A suggested rearrangement which seems rather plausible is shown in the accompanying chart. The eastern coast of South America is, as has often been pointed out, a quite exact counterpart of that of western Africa; a rotation of the African continent through about forty degrees would fill out almost as satisfactorily the basin of the Mediterranean, apart from a few insular and peninsular fragments that may naturally have suffered unknown displacement; Australia also is thus very well provided for. North America does not fit so well at its northern and southern extremities; Greenland and the abundance of adjacent islands however, suggest a good deal of disruption and rearrangement, too much to even guess at. The same is true for the region of the West Indies and the Gulf of Mexico. Central America strongly suggests a twist which has wrenched it out from between South America and Africa; and it is possible that such a twist, given by the crowding upon it of the end of the South American continent may have generated the peninsulas of Yucatan and Honduras with the gulfs at their left as transverse anticlinals and synclinals in the plastic, floating crust. Several island coasts closely resemble those of the adjacent mainland, as Madagascar and Greenland; this may be due to parallel foldings of the Earth's crust in more recent geological times; but where deep water separates them, as in the case of the Mozambique channel, the chasm is more likely to be primeval.

The University of Nebraska,
Lincoln, May 31, 1907.

MOTION OF THE GREAT RED SPOT ON JUPITER.

W. F. DENNING.

FOR POPULAR ASTRONOMY.

If any doubt existed as to the accelerating influence exerted by the south tropical spot on the motion of the Great Red Spot it

must have been removed by the results of observations during the last two years.

Between June 24, 1905 and May 4, 1906 the rotation period of the Red Spot was $9^h\ 55^m\ 41.5^s$. It was at the latter date well in conjunction, though not centrally so, with the south tropical spot moving at the rate of $9^h\ 55^m\ 19^s$ and the rotation of the Red Spot was quickened during the ensuing three months to the extent of seven and one-half seconds, the mean rotation value being $9^h\ 55^m\ 34^s$ during the ninety-six days May 4 to August 8, 1906 when Jupiter was too near to the Sun for observation of his surface markings. After that as the south tropical spot drifted west of the Red Spot and ultimately cleared itself from that object, the latter resumed its previously slow speed and during the following nine months to April 1907 showed a rotation period of about $9^h\ 55^m\ 42^s$.

The south tropical spot which is a large irregular dusky marking, or series of markings, in the south tropical zone of Jupiter, was first seen in February 1901 and since that time the motion of the Red Spot has been curiously irregular, the rate being sometimes less, sometimes more than the period adopted in the Marth-Crommelin Ephemerides $9^h\ 55^m\ 40.6^s$ (Daily rate 870°.27). During the last nine years the mean motion of the Red Spot has corresponded exactly with the above period, the longitude of the spot (25°) being at present about the same as it was in the summer of 1898.

The probabilities now are that the motion of the Red Spot will continue slow until the spring of 1908 when another conjunction with the south tropical marking will occur. Then the Red Spot will again exhibit a marked acceleration during the several months that it will be more or less involved with the south tropical disturbance.

A thorough investigation of the motion of the Red Spot since 1900 would probably lead to some very interesting deductions. The time appears to have arrived when all the available observations should be collected, both of the Great Red Spot and the south tropical marking so that their mutual influences as regards variable motion may be determined.

Bristol, England,
June 10, 1907.

THE DISTRIBUTION OF THE STARS.

HECTOR MACPHERSON, JR.

FOR POPULAR ASTRONOMY.

Even to the unaided eye, it is obvious that the stars are not evenly distributed over the heavens. The eye is at once attracted by such brilliant regions as Orion and Cygnus; while in Virgo and Capricornus there is plainly a dearth of stars. As Mr. Gore points out, of stars brighter than the second magnitude, of which there are thirty-two, twelve, or more than one-third are on the Galaxy or on faint nebulous light connected with it, and yet the area covered by the Galaxy does not exceed one-seventh of the whole heavens. This shows plainly that the stars are more numerous in the direction of the Galaxy than in other parts of the heavens. With a telescope the increase of stars in the galactic direction of the heavens is more apparent. In 1904 and 1905 the writer surveyed several hundred stars in all parts of the heavens with a 2-inch refractor, counting the fainter stars in the vicinity of brighter stars. Even with a small instrument the preponderance of stars in the Galaxy is at once obvious. In a telescopic field in Cygnus and Cassiopeia, for instance the average nunber of stars ranges from forty to sixty; while in a similar field in Capricornus and Virgo the average number is five or six. With larger instruments, of course, the increase is more obvious, as for instance with Herschel's reflector, which enabled that great astronomer to ascertain for the first time, the crowding of the stars towards the Galaxy.

When we come to examine great masses of stars the increase of stars towards the galactic belt is seen to be one of the laws of the stellar universe. In 1870 Proctor plotted on a single chart all the stars, to the number of 324,198 contained in Argelander's great "Durchmusterung" charts. The result was to show that, in his own words, "in the very regions where the Herschelian gauges showed the minutest telescopic stars to be most crowded, my chart of 324,198 stars shows the stars of the higher orders down to the eleventh magnitude to be so crowded that by their mere aggregation within the mass, they show the Milky Way with all its streams and clusterings."

This was confirmed by Houzeau of Brussels, and by the two Milan astronomers, Schiaparelli and Celoria. Schiaparelli confined himself to the lucid stars, those visible to the unaided eye, and the result of his work is to show that supposing the Milky Way were itself obliterated we could still trace its course by the

number of stars which aggregate towards the plane of the Galaxy. Mr. Gore finds that stars of each individual magnitude taken separately tend to aggregate on the Galaxy. From an enumeration of the stars down to the sixth magnitude, Mr. Gore shows that "the percentage of stars on the Milky Way is 22.1, or about one and a half times that due to its area." He also says—"The apparent connection of some of the naked-eye stars with the brighter portions of the Milky Way is in some cases remarkable. The stars Alpha, Beta, Gamma, Eta and Kappa Cassiopeiae mark a very luminous spot of Milky light. The stars Iota, Kappa and Lambda Andromedae mark another. Delta, Epsilon and Zeta Cephei lie near the edge of a 'coal-sack', or dark space in the midst of a luminous region. The stars Epsilon, Xi, Zeta and Omicron Persei mark an off-shoot from the Galaxy in the direction of the Pleiades." Another interesting example, not pointed out by Mr. Gore, is the region of Deneb or Alpha Cygni as observed with the binocular. In August 1904 the writer noted "that the boundary between the galactic light and the darkness of the small rift near Alpha Cygni is marked by a line of stars which appears distinctly connected with the nebulous light of the Galaxy." This field is one of the most striking examples of the connection of the lucid stars and the galactic star-clouds.

The Dutch astronomer Easton has ascertained that the fainter stars in Argelander's catalogue, about 9.5 magnitude "present in the manner in which they are distributed, a remarkable correspondence with the luminous and obscure spots in the Milky Way." Celoria finds that among the fainter stars there is a marked increase of stars towards the Galaxy. Seeliger in his researches divides the sky into nine zones, each twenty degrees in breadth, by small circles parallel to the Galaxy. As the writer has said in "Astronomers of To-day":—"In Professor Seeliger's first region is included 4,277 stars, in the second, third, and fourth respectively 10,185, 19,488, and 24,492 stars. The maximum is reached in the fifth region, which contains 33,267 stars and it is to be noted that this is the galactic zone. The sixth region contains 23,580 stars, and the seventh, eighth, and ninth respectively, 11,790, 6,375, and 1,644 stars. The number of stars gradually increases from each of the galactic poles to the Milky Way itself."

The Galaxy, seems therefore to be the ground-plan of the stellar universe, "the ecliptic of the stars" as the younger Herschel called it; and the aggregation of stars towards the

galactic plane is admitted on all hands. The problem of how to interpret this fact has exercised the minds of astronomers since the time of the elder Herschel. There are three possible explanations of this aggregation which are (1) Uniform distribution of stars, but further extension in the galactic line of sight; (2) Greater condensation of stars in the Galaxy than elsewhere; and (3) Greater condensation and at the same time greater extension. The first of these explanations was at first accepted by the elder Herschel in 1785 in his famous disk-theory of the universe. He assumed the stars to be distributed on the whole in a uniform manner throughout space, but the stellar universe to have a greater extension in the galactic line of sight. Herschel was thus able to compute the shape and extent of the universe, which he regarded as finite. He sketched the disk as cloven at one of its extremities to represent the famous gap in the Galaxy. He soon found however, that the disk-theory failed to explain the observed facts and that the stars were by no means uniformly distributed; so he abandoned the theory definitely in 1811, and he never put forward another hypothesis to explain the crowding of the stars on the Galaxy. The elder Struve attempted a modification of the disk-theory, which never became popular among astronomers and was abandoned years ago. He regarded the stellar universe as a disk of certain thickness, but of infinite diameter. His idea was that the light from the farther stars in the direction of the Galaxy suffered extinction in the ether, and thus he explained why, granting the infinity of the Galaxy, the entire heavens did not shine with the brightness of the Sun. Sir John Herschel and Grant of Glasgow gave the death-blow to Struve's theory, which was never accepted. Proctor who was the next great student of star distribution after Struve, threw over the fundamental idea of the disk theory—equal scattering. He pointed out that "within one and the same region co-exist stars of many orders of magnitude, the greatest being thousands of times larger than the least." This is a conclusion quite different from the disk theory, where the stars were supposed to be on the whole distributed uniformly and to be of a uniform size.

Celoria and Seeliger both consider the Galaxy to be a zone of stellar condensation, where the stars are smaller and more closely crowded together than in other parts of the heavens. Newcomb, however also thinks that "the Universe extends farther around the girdle of the Milky Way than toward the poles of that girdle," and that "outside the galactic region the stars in general

show no tendency to collect into systems or clusters, but are mostly distributed through space with some approach to uniformity." In regard to the distances of the galactic stars, Proctor thought the stars which make up the milky light to be smaller than the brighter stars and to be at a smaller distance than their faintness would lead one to suppose. Easton points out that "in general the faint stars which form the Milky Way are thickly or sparsely scattered in respectively the same region as Argelander's last class; it follows, therefore, with a great degree of probability that there is a real connection between the distribution of ninth and tenth magnitude stars and that of the very faint stars of the Milky Way. Consequently the very faintest stars are at a distance which does not greatly exceed that of 9-10 magnitude stars. If stars of 11-15 magnitude were at their theoretical distance, there would be no reason why they should have the same apparent distribution as 9-10 magnitude stars, separated from them by enormous distances."

The galactic zone, though part and parcel of the stellar universe, seems to have several well-marked characteristics of its own. Kapteyn, Gill and Pickering independently discovered the predominence of first-type stars in the Galaxy; while Kapteyn showed that the near vicinity of the Sun consists almost exclusively of stars of the second type. Another peculiarity of the galactic region is that outbursts of temporary stars are commonly confined within its bounds. The photographs of Wolf, too, have revealed in Cygnus, Aquila and other galactic constellations, enormous masses of nebulæ intermixed with the stars. This seems to point to the stars of the Milky Way being relatively younger than those in other regions of the heavens, and to the zone being in a more chaotic condition than the vicinity of our Sun.

Sir John Herschel believed the Galaxy to be a ring formation, and Proctor put forward the view that it was of a spiral form, the gaps and "coal-sacks" being due to loops in the stream. Both Gould and Celoria thought that the Milky Way is really composed of two galactic rings, but neither of these ideas have been accepted. There seems to be no doubt that the Galaxy is a ring-formation and a distinctive part of the universe, but as Seeliger points out, "it is no mere local phenomenon, but is closely connected with the entire constitution of our stellar system." The number of stars in Seeliger's enumeration increases from each of the galactic poles to the Galaxy itself. This shows that the Galaxy is not merely a ring of stars surrounding a star-sphere,

for if such were the case, the number of stars would increase not speedily but suddenly near the boundary of the ring.

Sir John Herschel considered that our Sun is not placed centrally in the plane of the Milky Way; and the idea is confirmed by Celoria, whose observations indicate that we are nearer to Aquila than to Monoceros. The idea that the Sun and nearer stars form a separate cluster has been abandoned by Kapteyn, its author, whose recent researches on star streams have led some astronomers to the conclusion that the universe is double; but it is obviously too early to formulate any definite theory on this point.

With regard to the distribution of stars in the universe, the Galaxy seems to be a real region of condensation; and at the same time the universe probably extends further in the direction of the Galaxy than in the direction of the galactic poles. In the latter direction, in fact, the limits of the universe have been reached by Celoria's telescope before the eleventh magnitude and this fact supports Newcomb's view that the universe is farther extended in the galactic direction; but it is quite evident that even in the Galaxy itself the stars thin out at the lower magnitudes, and the rifts and coal-sacks indicate that there are no farther stars in their respective directions. If the views of Newcomb and Seeliger are correct the universe would seem to be of a roughly spherical shape, flattened at the poles, with an equatorial bulge; and the equatorial region would seem to be densely crowded and at an early stage of evolution. But as Mr. Gore has truly remarked—"The Copernicus of the Sidereal system has not yet arrived and it may be many years or even centuries before this great problem is satisfactorily solved."

Johnsburn, Balerno.
Midlothian, Scotland.

THE FIRST GENERAL CATALOGUE OF DOUBLE STARS.

R. G. AITKEN.

FOR POPULAR ASTRONOMY.

A REVIEW.

[A GENERAL CATALOGUE OF DOUBLE STARS WITHIN 121° OF THE NORTH POLE. BY S. W. BURNHAM.

PART I. THE CATALOGUE; PART II. NOTES TO THE CATALOGUE.

Published by the Carnegie Institution of Washington, 1906. 4-to. LV + VIII + 1086 pages.]

In closing my review, in this journal in 1900, of Professor Burnham's General Catalogue of his own double star discoveries, I ventured to refer to the manuscript catalogue of all double stars which he was known to possess and to express the hope "that the means may soon become available to put this work—the result of years of patient labor—into the permanent form now assumed by the General Catalogue of the β Stars."

A year or two later all double star observers rejoiced to read the announcement that the Carnegie Institution of Washington would print this catalogue as No. 5 of their publications. But Mr. Burnham was not willing to let his manuscript go to the printer until he had thoroughly revised it, freed it, as far as was humanly possible, from errors, and brought up to date the history of the stars included in it by collecting all available unpublished material and by making, personally, nearly ten thousand additional measures of neglected pairs with the 40-inch refractor of the Yerkes Observatory. When the enormous amount of labor involved in such an exhaustive revision is considered, and an estimate is made of the time required for one man to draw the numerous diagrams, prepare them and the manuscript for the printer, and read all of the proof, it will not seem strange that five years elapsed before the finished volumes were distributed. Rather, one is moved to marvel at the man who, single-handed, could carry such a task to such successful issue.

In the form in which the work is now presented to us the catalogue proper makes a handy quarto volume of 256 pages with LV additional pages devoted to a brief introduction, indexes and precession tables, and an appendix of 18 pages containing the discoveries of double stars at the Lick Observatory which were published too late for insertion in their order in the main catalogue. In all 13,655 pairs of stars are entered. As would be expected by any one who has used the catalogue of β stars, the arrangement of the material leaves nothing to be desired either in the way of convenience for practical use or in the way of good typography.

The present writer has handled the book daily for several weeks and has found it admirably adapted to its purpose. The large page affords room for eleven columns which give, in order, for each star its current number, its designation as a double star (and in this column the device of setting the Σ, 0Σ and β numbers on the line and indenting the others adds to convenience as well as to the appearance), a star-catalogue identification where possible, the Right Ascension and Declination for

1880, the Position Angle, Distance, Magnitude, Epoch, and Observer (these five columns giving, generally, the first published observation of the star), and finally, a brief column for Notes. In this column besides other pertinent matter, references are given, when short, for stars observed at one epoch only, which therefore need no note in Part II. The indexes enable one to find any desired star quickly, or to look up all the members of a particular class of stars, e. g.—binaries for which orbits have been computed, stars of the 61 Cygni type, stars with common proper motion, etc., and the precession tables, which follow, facilitate the comparison with the Catalogue of lists referred to another epoch.

From this account it will be seen that Part I is in a sense complete in itself and that it will answer every purpose for one who desires only to know what stars are double, to what class they belong, and where they are located. Obviously the essential qualities of such a work are *completeness* and *accuracy*, and the present writer has been at some pains to test the Catalogue in both particulars. The inclusion of all the stars in the well-known long lists—the Σ, 0Σ, β, Ho, stars—may be taken for granted. I have not compared these lists with the Catalogue, but have looked up numerous shorter lists and a long list of miscellaneous stars, and have also compared the Catalogue with many sky areas that I had thoroughly examined with the telescope. So far, I have found no omissions and only one error of position. This is of the pair Es.75, Catalogue, No. 6143. Espin has correctly identified this pair as BD. + 46°.2054, but in A.N. 3784 he gives the hour of R.A. as *12* instead of *15* and Burnham has naturally copied his mistake. That other errors will be discovered in time is to be expected, but it is certain that they will be very few and comparatively unimportant.

Though Part I is complete in itself for many purposes, to study the history of the individual pairs and to look up the references to the original papers one must turn to Part II which is bound separately in a volume of 828 pages. Here will be found, after six pages of abbreviations of the references most frequently cited, a concise account of every star in the Catalogue which has been measured at more than one epoch together with references to all the measures including many thousands now printed for the first time. The liberal use of diagrams in this part of the work is heartily to be commended. Besides adding to the attractiveness of the book typographically, they give a clearer idea of the

character of the motion in the systems under discussion than pages of measures or verbal description could possibly do.

Part II is arranged for convenient use in connection with Part I, or, if the approximate Right Ascension of the star is known, for independent use. This is effected by repeating in bold faced type the current number given in Part I and also in lighter type on the left-hand margin of the page, the minute and second of Right Ascension, the hour being printed on the upper corner of the page.

The author tells us that he was "not handicapped or limited in any way as to the space to be used," the questions of what material should be included and of how it should be treated being left wholly to his judgment. If he had desired to make a "monumental" work it would have been easy to do so, much easier than to confine it within its present limits. But the author wisely decided not to give all of the measures, good and bad, of the more familiar pairs many of which have been measured hundreds of times. For each of these stars he gives ample material selected from the best measures to bring out the character of the motion. In many cases, as he himself says, more measures are given than are really necessary, but his endeavor has been to omit nothing of real value. To make these selections and to write notes that are brief and at the same time adequate requires good judgment, careful study and thorough familiarity with the work of all double star observers, to say nothing of time and patience. The result is all that could be desired.

Every one who has investigated double stars at all will endorse Professor Burnham's plan of giving only selected measures of the frequently measured pairs. This amounts to an expert's criticism of the measures and adds greatly to their value. If the investigator in any case wants all the measures, he also wants them in their original form and the complete references given in the Catalogue enable him to look them up for himself. As for the comments, it is inevitable that there should be diversity of opinion respecting the motion in many of these systems and probably no two double star workers will agree in all cases. All that can fairly be asked of the compiler of such a work as this is that he be sane, conservative, and impartial; and in these respects Mr. Burnham's work fully meets all requirements. While the present writer does not agree with all of his conclusions, he regards the work of comment as a whole to be admirably well balanced.

After all, it is wholly immaterial whether we accept the author's judgment in every case or not. We shall certainly find

his comment on any system worthy of most careful consideration and, in my opinion, generally sound. But the important matter here as in Part I, is whether the work is complete and accurate. It is obviously impossible to check every reference, but so far as I have done so in selected cases the references have been found complete. In fact the work is so accurate throughout that it was rather a relief to find one discrepancy. On page 291, the note on ϕ Andromedae rightly states that "it has recently become much closer," but in the diagram the last three positions make the distance greater than it was in 1890. In a personal letter the author has sent me two plate corrections missed by the printer which it may be well to repeat here. On page 1071, star 4501, for "0.″013 in 243.°3" read "0.″024 in 199.°8"; and on page 1076, star 6869, in the eleventh line, for "larger" read "similar" and in the next line for "1.″696" read"1.″382". So far as my present knowledge goes, there are no other errors, except a few quite insignificant typographical ones, in the entire work.

Since this great Catalogue will undoubtedly mark a new epoch in double star astronomy as definitely as did the *Mensurae Micrometricae* in Struve's time it is of the greatest importance that every inaccuracy in it be corrected. I suggest, therefore, and I feel sure the author will second the suggestion, that any errata discovered be promptly sent to Mr. Burnham that he may, when he deems it advisable, print a list of them.

I have purposely refrained, so far, from any comment on Professor Burnham's Introduction to this work, for it was evident, on examination, that he considered the Catalogue itself, and not any discussion he might make of its contents, as the important matter. The very brevity of the introduction, however, adds emphasis to the questions he does discuss and a few paragraphs on these, and some quotations, may not be out of place.

Every one will agree that Burnham has placed the southern limit of Declination (—31°) low enough for all practical purposes. It is to be hoped that the renewed attention thus called to the urgent need of measures of the more southern double stars will lead to some systematic effort to observe them.

There can hardly be any difference of opinion, either, on the propriety of including in this Catalogue all objects that have heretofore been listed as double stars whether worthy of the name from our modern standpoint or not. A careful study of the notes and measures in Part II strengthens the present writer in the opinion already strongly held that a very large percentage

of the 13,655 pairs in the Catalogue should be disregarded by double star observers hereafter. As Burnham says: "It is certain that of the 13,655 stars contained in this Catalogue, at least several thousand are only optical or accidental pairs, and can have no physical relation to each other. This includes nearly all the pairs of Herschel II, as well as of Herschel I which are not included in the *Mensurae Micrometricae*; many of the Struve and Otto Struve stars; and more or less from all the modern lists. The question of drawing some kind of arbitrary line between what might be presumed to be physical systems, and those which it was practically certain could not belong to that class, was considered at an early day in the preparation of this work."

Happily no satisfactory line could be drawn and we also heartily agree with the author when he goes on to say that "the names of the great astronomers attached to these stars entitle them to a place in the first general catalogue of double stars, independent of any consideration of the stars themselves." He continues: "I have therefore included them all, and as far as possible remeasured the large number of neglected pairs of the old observers for this work."

This course has resulted in a work that gives us a complete historical survey of the progress of double star astronomy, and by studying it we can decide which pairs to drop altogether from our observing lists, which ones to measure only once in a life-time and which to measure at regular intervals of from a few months to ten or more years. As Burnham remarks again; "It will be seen that the micrometrical work on double stars since the observations of Struve has not been wisely distributed. A vast amount of time has been practically wasted in the duplication of measures of prominent and familiar pairs and in observing objects which need no attention except at long intervals. Much more would be known of most of the double stars if the observing lists had been more carefully selected during the last sixty years."

It is to be said that the preparation of an observing list that would contain only objects worth measuring has hitherto been a difficult matter because of the lack of just such a book as this Catalogue. Hereafter there will be little excuse for wasted work of this kind. The present reviewer is also strongly of the opinion that little or no excuse now exists for adding to the double star lists pairs which cannot, an any reasonable hypothesis, be expected to show the least motion in a century. No useful purpose is served by burdening the catalogues with such objects, for

the pairs in which motion *may* be expected within an observer's life are numerous enough to engage the full attention of all the astronomers likely to devote their time to this work.

Burnham gives an interesting table showing the distribution of the 13,655 double stars according to Right Ascension. As might be foretold, the distribution curve rises to a high and sharp maximum in the neighborhood of 19 hours with a corresponding minimum in the hours 10 to 13. A secondary maximum occurs near 6 hours and a secondary minimum in 2 and 3 hours. Burnham follows the table with the remark: "It would not be difficult, by a sorting-out and arrangement of the supposed classes of doubles with reference to the distribution in the heavens, to deduce various inferences based upon such statistics. But it seems certain at this time, with the extremely limited information furnished by all the discoveries and observations that all such conclusions would be idle and useless." One is tempted to quote the whole of this long paragraph for it is sound sense, and one of the closing sentences must be added.—"At present all that is needed for all the double stars, old and new, and of all orders of brightness, is careful and systematic measurement. When this has been carried far enough to furnish the necessary facts, theories and speculations will be in order....."

In another paragraph Burnham reiterates his well-known opinion that orbits based upon short observed arcs are valueless. He has so well succeeded in impressing this sound doctrine upon most double star workers that comparatively few useless orbits are now being published. It is interesting and significant that in Part II he does not give a single new orbit, though in his diagrams he often gives an ellipse which is one of the 'possible' orbits of the pair under discussion.

In turning over the leaves of this volume again, the reviewer notes numerous individual stars upon which he would like to comment, but once started in that field it would be difficult to stop. Enough has been said to show the character of the Catalogue. It is at once a complete and reliable history of practical double star astronomy from its inception to the present time and a trustworthy guide to future progress. If, by its aid, careful observing lists are prepared, and equal care is taken to add only the closer pairs to the lists of known double stars, the next seventy years will show progress in this field even more remarkable than that which is revealed by a comparison of this General Catalogue with the *Mensurae Micrometricae*.

Lick Observatory,
July 22, 1907.

NAKED EYE COMETS.

W. F. DENNING.

I recently compiled a table of all naked eye comets recorded as having been observed in the N. and S. hemispheres since 1850 and the aggregate reached 59, so that on an average we may expect to be visited by one of these comets per annum.

As to the bright comets of 1874 (Coggia), 1881 (Tebbutt), and 1882 (Cruls) they were fine objects, but the former in regard to the length of its tail was the largest, as on 1874 July 15 it extended over 45°, whereas the length of tail, as traced at Bristol of the comets of 1881 and 1882 was about 15° and 23° respectively.

Tebbutt's comet of 1881 was certainly entitled to a rank, from its striking aspect in the last week of June, as a really conspicuous object. When I first saw it about midnight on June 23 I estimated the nucleus as larger and more conspicuous than Capella, though not of the same sparkling brightness. The tail was 15° long on June 25.

Coggia's comet of 1874 was noteworthy from the fact that its tail remained a fine spectacle after the nucleus had descended below the horizon. For about a week following the middle of July the tail stretched upwards from the northern horizon to the stars of Ursa Major and looked like a broad shaft of Aurora widest at the upper extremity.

Of 105 comets seen from Bristol during the last 40 years, those of 1874, 1881, and 1882 were entitled to precedence as forming the most striking objects in point of size and brightness.

Large comets appeared in the southern hemisphere in 1880, 1887, and 1901.

Since the great comet which was visible in the autumn mornings of 1882 we have had many fairly conspicuous naked eye comets, but not one of really first class magnitude has made its apparition in the northern hemisphere.

A large specimen of these mysterious visitors would be welcomed as likely to enhance our knowledge in view of the effective spectroscopic and photographic means now at our disposal.

Bristol,
June 23, 1907.

THE DISTANCES OF THE FIXED STARS.

J. M. SCHAEBERLE.

In various astronomical and other scientific publications misleading statements are frequently made concerning our knowledge of the distances of the fixed stars. In parallax work practically all reliable observations are of a differential nature, and the interpretations of the resulting measures for distance are largely dependent upon preconceived views as to the arrangement of the stars in space.

For some years past I have been engaged in observational and theoretical work on that intricate problem—where is the origin and what is the physical structure of our sidereal system? The results so far obtained are novel, since they indicate that the structure is radial, in other words the stars and nebulas of our system are moving either directly towards or directly away from our Sun; the observed deviations from radial motion being attributed to the unsymmetrical distribution of the attracting masses, and also to the presence of bodies having a secondary origin.

The indications also point to the conclusion that, as seen from our Sun, a vast majority of the stars and nebulas are confined to a region whose radial depth is much less than the distance of this region from our Sun. Since bodies so situated may be comparatively near to us and still have various radial velocities without causing sensible changes in the configuration of the heavens, the seemingly unchanging aspect of the Milky Way* and other celestial regions is explained without the necessity of assigning such great distances (and consequently such great masses) to the bodies of our system.

Considering the still undetermined constants entering into the problem, and the lack of a rigorous method for making direct measures, it surely is no exaggeration to say that a trustworthy value of a star's parallax has not yet been obtained.

The award of the Boyden Premium by the Franklin Institute to Dr. Heyl is doubtless a well-deserved honor, but when one reads in *Science* for June 28, 1907, on page 1013, that a definitive result is based upon the wholly unproved claim that "the distance of Algol is no less than forty light years" it seems desirable to emphasize the fact that in the present state of our knowledge the approximate distance of any particular fixed star must still be regarded as an unknown quantity.

Science.

* Whether the theory is in agreement with the actual facts or not, I demonstrate that the inclination of the plane (?) of a Milky Way to the plane of the Sun's equator is a necessary consequence of such a structure.

THE ALVAN CLARK AND SONS CORPORATION.

W. W. PAYNE.

It was my privilege while visiting in the East a few weeks ago, to spend some time at the old shops of the famous Alvan Clark and Sons, so well-known everywhere in astronomical circles for nearly a half of a century. In the seventies I needed a small telescope to begin the study of astronomy in Carleton College, to which I had then been called as instructor in that science. The only place of which I then knew that was attractive to me was that of Alvan Clark in Cambridgeport, Massachusetts. I shall never forget the kindly reception that greeted me when first I met the Clarks at their shops at the same place in Cambridgeport where telescope-making and other kindred work are now going on under essentially the same name.

When I told Alvan Clark senior what I was planning to do in the study and teaching of descriptive and practical astronomy, and that I needed, first of all, a telescope for effective work, I was made to feel very much at home immediately. He spent hours telling me about the great glasses he had been making, and something about the noted astronomers who had visited him while he was making telescopes for them, and then he took me through his shop to show me what they were then doing.

That tall, erect, elderly gentleman in all his simple, direct and most cordial ways made a deep impression on me, as a young man, at that first meeting. I can never forget him as he then was. In answer to the question how his work began, he told me of the interest his sons, George and Alvan, showed in mechanical work while they were quite young, especially in the line of trying to make telescopes. It was to encourage those boys that the father began, in a small way, to help them do useful work in the line of their inclinations and probably in the leaning of their own young minds. The father was not then an expert in grinding lenses. He had to learn the art, and he did it in his own way. To our mind that fact was a secret of his large success achieved in after years. He was no copyist for at that time there was little that could be copied in the science of telescope-making by such a man as was Alvan Clark. He sought information about things he did not know from every available source, of course, but he put that knowledge to the actual test of experiment before its use, and in that way he could certainly learn what such knowledge was worth.

It was fortunate that his work was done so near to Harvard College, where he could get such help as he needed in the applied mathematics, if the professors there were disposed to aid him. It is in this thing too, that the mind of Alvan Clark is seen in its true light. If he had not been a man of noble parts it is doubtful if those distinguished men of Harvard College, in his time, would have cared to spend very much of their precious time in solving knotty physical problems to help a novice in the art of making telescopes, who at the first had neither reputation nor ability to do work of a grade high enough to command much attention.

But all this was soon changed, for between 1860 and 1892, the Clarks were asked at five different times to make a telescope more powerful than any then in existence, and they did it, each time increasing the aperture of the object glass from one to six inches. These telescopes in order were the 18½-inch refractor of the Dearborn Observatory, now at Evanston, Illinois, the 26-inch refractor for the Naval Observatory at Washington and another of the same size for the University of Virginia; the 30-inch refractor for the Imperial Observatory at Pulkowa, Russia; the 36-inch refractor for the Lick Observatory on Mount Hamilton, California, and the 40-inch glass for the Yerkes Observatory at Williams Bay, Wisconsin; the last being still the largest refracting telescope now at work in the world. It is an interesting fact that all these great instruments are now actively at work, and have been so since they were mounted. They have been used by the strong practical men in the science who have had a large part in making American astronomy what it is today.

The large telescopes of smaller size and some of them of more recent make have been secured by able astronomers in connection with colleges or universities, or for the purpose of equipping private observatories for special lines of work. Of these we may mention Professor Charles A. Young of Princeton University who obtained from this firm a 23-inch glass, which he used during his long connection with that university; a 24-inch telescope made for Percival Lowell who mounted it in his private observatory at Flagstaff, Arizona, a place from which has come the most thorough, painstaking and complete work on the study of the surface of the planet Mars known to present-day astronomy any where in the world. It was fitting that Amherst College at its last annual commencement, should honor him with the degree of doctor of laws for the meritorious work he has already accom-

plished as an observer, lecturer and forceful writer of books pertaining to that interesting planet.

For some years before Alvan Clark, senior, passed away in the year 1887, at the advanced age of eighty-three, he was not able to do much work at the shops chiefly because of years, for physically he seemed to be well, and as keen of mind and interest in the work going on there as ever. The last time I saw him was during this period of his later life. He was then in these same shops, and, at that time, he was assisting his son, Alvan G. Clark in testing a large lens, in the long, underground room used for that purpose. I stood beside him for some time, as he shifted the lens from one position to another that his son might determine the figure of the glass at every point on its surface while he sat more than forty feet away in the dark with an eyepiece for observation. I shall probably never forget the pathetic words he then spoke to me about himself. He said: "They will not let me do that kind of work any more. They think I am too old." If memory serves me rightly these were the exact words he used. The tinge of sadness in them was doubtless from the memory of that unique skill which had been his in former years when the delicate touch of his fingers on glass surfaces meant so much for him and for the art of glass polishing in which he scarcely had a rival in the world.

As I stood the other day in these same old shops with Mr. Carl Lundin and his son, both of them royal men in the same business of making telescopes, I could but run over in my mind some of these interesting points of history that have figured so prominently in many ways in modern astronomy.

Many of our readers already know that Mr. Lundin served under all the Clarks, and that he has been at the same place for more than thirty years almost entirely in optical lines of work. His apprenticeship under the Clarks and his large experience since has made him one of the foremost opticians in this country, and the worthy leader that he now is of the old Clark firm of the past.

When Mr. Lundin was showing me his devices for testing the surfaces of large lenses in the same underground room I have mentioned, and I had looked at one of his noble flats and somewhat realized the care and the skill needed in doing some optical work that he had recently turned out, I was fully convinced that the mantle of the Clarks had fallen on very worthy shoulders. How true it is that patience and experience will work wonders! Mr. Lundin has both of these excellent qualities and

he has obtained them in a way to make him the noble optician he is.

I was also much interested in examining an altazimuth and equatorial mounting combined for a small telescope. The head-piece of the mounting is so constructed that the table of the telescope may be given a steady altazimuth movement, when that kind of observation is desired, or, by means of an easy and quick change, the instrument is adapted to equatorial motions and the observer is at once provided for that kind of astronomical work. From the small instrument I saw, it is difficult to imagine any light and portable mounting for a small telescope that would be more desirable or convenient than this. We have no suitable photograph of such a mounting or it would be given in this connection. Application to Mr. Lundin by anyone interested would doubtless bring promptly any further information that may be desired.

In the foregoing I have said very little about Mr. George Clark whom I knew better than either of the other members of the old firm. He was once for a few days in Northfield, Minnesota, when the first telescope of the old observatory was mounted. At that time he gave special attention to the mountings of the telescopes the firm was building, and the ability with which he did that mechanical work for large instruments has been spoken of favorably by those who knew of it most thoroughly.

NORTH POLAR CAP OF MARS.

PERCIVAL LOWELL.

When observations of Mars were begun by me at this opposition, on March 22, the North Polar Cap of the planet could just be seen, a small white spot at the edge of the northern disk. The cap thus showed reduced to its smallest dimensions, or in other words as the old polar cap of the winter before, and thus it continued to present itself until well into April. Its breadth east and west in the several drawings of late March and early April was:

Earthly Date	Martian Date ☽	Martian Longitude °	Diam. in Degrees °
March 22	⊙ = 141.6 Aug. 14	λ = 278	8.5
March 24	⊙ = 142.6 Aug. 15	λ = 276	8.0
March 28	⊙ = 144.6 Aug. 17	λ = 210	8.4
April 2	⊙ = 146.6 Aug. 19	λ = 160	4.6
April 6	⊙ = 149.2 Aug. 22	λ = 130	7.1

Since B, the latitude of the center of the disk as seen from the Earth, was

$$= 1°.6 \text{ on March } 22$$
$$= 2°.8 \text{ on March } 28$$

the maximum diameter visible fell short of the reality, the two being about as 84 to 100. On the other hand, irradiation increased the apparent size by some 2°.3, so that this correction practically offsets the other.

On April 6 the last drawing was made of it in its old state; for on April 8 a large white patch appeared to the left of it, extending far down the latitudes, marking the first frost of the on-coming autumn. Patches of great size in and about the arctic regions were in evidence during the next fortnight, sometimes permitting the old cap to show, sometimes obscuring it, and not until April 21 did the cap settle down to a permanent increase of snow-covered area. From that time on its latitudinal limits were, at selected dates:

Earthly Date	Martian Date ⊙	Latitudinal Limit ○
April 21	⊙ = 157.5 Aug. 31	53.5 N
April 24	⊙ = 158.5 Sept. 1	59.7 N
April 26	⊙ = 159.6 Sept. 2	60.9 N
April 30	⊙ = 161.7 Sept. 4	66.9 N
May 4	⊙ = 163.9 Sept. 6	59.4 N
May 6	⊙ = 164.9 Sept. 7	54.4 N
May 8	⊙ = 166.0 Sept. 8	68.5 N
May 14	⊙ = 168.7 Sept. 11	Just visible along horizon of disk
May 20	⊙ = 172.2 Sept. 15	
May 28	⊙ = 177.0 Sept. 20	49.1 N
May 31	⊙ = 178.7 Sept. 21	56.5 N
June 4	⊙ = 181.0 Sept. 24	58.6 N
June 12	⊙ = 185.5 Sept. 28	66.9 N
June 14	⊙ = 186.7 Sept. 30	56.9 N

From this data it appears that the cap began in the same sudden and extensive manner that had characterized its advent in 1903 and 1905 (see Bulletins 2 and 22). Furthermore that the frost fell to melt again on the next succeeding days, to be followed by another fall a little later.

This curious manner of making of the cap seems to be a consequence of a no less curious mathematical deduction from the general problem of the daily insolation upon a planet. This led me to take up the consideration of that insolation.

Insolation. The question of the amount of the daily insolation due the Sun received at different latitudes by a planet of which the axis of rotation stands tilted to the plane of its orbit is of some interest, and the more so that the results of analysis appear

to have practical exemplification in the case of the planet Mars.

To determine the amount of the insolation at any point of the surface of a planet we may proceed as follows:

Let a = the co-altitude of the Sun at the point at a given moment. Then cos a = the relative intensity of the insolation then and there, neglecting the absorption of the air and the varying distance of the Sun.

Let b = the co-latitude of the point on the surface.

Let c = the co-declination of the Sun at the time.

Let A = the hour-angle reckoned from noon.

Then by spherical triangles we have

$$\cos a = \cos b \cos c + \sin b \sin c \cos A$$

which expresses the intensity of the insolation as a function of the hour-angle.

To find the whole insolation received at the point during the day we have, calling that insolation I;

$$I = 2\int_0^{A'} \cos a \, \mathrm{d}\, A$$

where A' denotes the hour-angle corresponding to sunrise or sunset, reckoned from noon, one way and the other. To find A' we note that at sunrise or sunset $a = 90°$; whence its cosine is zero, and from the equation

$$\cos a = 0 = \cos b \cos c + \sin b \sin c \cos A'$$
$$\cos A' = -\cot b \cot c$$

$$\text{whence } A' = \text{arc cos } (-\cot b \cot c).$$

Substituting in the integral we get

$$I = 2\int_0^{\text{arc cos } (-\cot b \cot c)} (\cos b \cos c + \sin b \sin c \cos A)\mathrm{d}\, A$$

and so

$$I = 2\left\{\begin{matrix} \cos b \cos c \text{ arc cos } (-\cot b \cot c) \\ + \sin b \sin c \sin \text{ arc cos } (-\cot b \cot c) \end{matrix}\right\}.$$

The first thing to notice about this function is that $-\cot b \cot c$ may have a value exceeding unity, and consequently its cosine becomes illusory. Such event means that cos a does not vanish, and therefore that the Sun never sets on that day and that the upper limit of the integral is $A' = 180°$.

Now as b decreases from the equator to the pole its cotangent increases more and more rapidly, consequently the arc A' in-

creases more and more rapidly from 90° on and its sine decreases still faster. On the other hand, cos b increases slower and slower from equator to pole, while sin b decreases faster und faster. If cos b cos c and sin b sin c were the two terms, we should have a single maximum between 90° and 0°, which, if c were 45°, would itself be at 45°. But one of these terms is multiplied by A', the other by sin A', and this causes the function to have two maxima, and, of course, two minima. Their position will depend upon the value of c.

For the Earth, at the summer solstice, when $c = 23° 27' 4''$, we find the maxima and minima insolations with their numerical values, that at the equator at the equinox being reckoned as unity, to be as follows:

INSOLATION FOR THE EARTH AT THE SUMMER SOLSTICE FOR DIFFERENT LATITUDES.

N. Pole (maximum) - - - -	1.250
" 61°.8 (minimum) - - - -	1.136
" 43 .5 (maximum) - - - -	1.153
Equator - - - - - - - - -	0.917
S. 66 .6 (minimum) - - - -	0.
" Pole (minimum) - - - i	0.

Thus there is a maximum of heat received from the Sun on a midsummer day at the North Pole and another less great in mid-temperate latitudes. The latter helps certainly to make New York in summer as hot as it is. That the climate of the arctic regions is not warmer is due chiefly to the accumulation of ice there, all of which has to be melted before the temperature can notably rise; and it takes 80 times the caloric to melt a pound of ice at 32 F. to a pound of water at the same temperature as to raise that pound of water subsequently 1° C.

Turning now to Mars, the tilt of whose axis to the plane of its ecliptic is 24°.0*, we find:

INSOLATION ON MARS AT THE SUMMER SOLSTICE.

N. Pole	1.278	The insolation at the equator at the equinoxes being taken as I.
" 60°	1.154	
" 44°.5	1.163	
Equator	.913	
S. 66°	0.	
" Pole	0.	

At the equinoxes the insolation is unity at the equator, there as here.

* See Lowell Observatory Bulletin No. 24. This value is to be adopted in the British Nautical Almanac, beginning with 1909.

It thus appears that the accentuation of the insolation in the polar regions during the summer is even more pronounced on Mars than on the Earth, which is one cause of the great melting of its polar caps.

At the equinox, the declination of the Sun being nothing, $c = 90°$, consequently A' becomes 90° for all latitudes and the insolation

$$I = 2 \sin b$$

or the insolation is as the sin colat or as the cos lat. It, therefore, decreases from the equator to the pole, and there is then but one maximum and one minimum, the upper minimum having gone up to the pole, and the mid-latitude maximum descending to the equator.

Since, therefore, at the solstice the function increases polewards from latitude 60° and decreases thence polewards at the equinox, at some date between the two the values of the insolation at the pole and at 60° latitude must be equal. For Mars this date proves to be $\odot = 130.°2$, corresponding to our August 3. The declination of the Sun is then

$$18° 6'$$

and the value of the insolation for both points

$$I = 9.76.$$

Now, in this fact may be found an explanation of a most curious Martian phenomenon. When the cap starts to form in the autumn, it proceeds to develop not by successive slow increments to the edge of the old kernel, but by a sudden light deposition of frost extending down the parallels to about latitude 60°, and enveloping a vast region in its fall (see Lowell Obs'y Bulletins 2, 22, 30). For three consecutive Martian years now has this phenomenon occurred, the manner and even the date of the cap's making reproducing itself year after year. Thus in 1903 the first frost in the arctic regions of Mars was observed to occur at $\odot = 149°.9$, in 1905 at $\odot = 149°.0$, in 1907 at $\odot = 150°.2$, dates corresponding to our August 21, 22 and 23—approx. The punctuality of the event is surprising. Having thus been deposited, the frost proceeds to melt in part, to be followed in a few days by a heavier fall extending a little farther down, and so by waves of recession and advance the cap is eventually built up.

This is just what might occur from a greater insolation polewards, not only at the solstice, but for six weeks (Martian) afterwards, and which then became equal throughout the whole

arctic and the northern part of the temperate zone. For the fall in insolation to a substantial equalization throughout so extensive an area would, in the absence of an atmosphere, connote a similar fall in temperature, and if this temperature were that of freezing, a vast snow deposit would result. An atmosphere would delay the date of equalization by retaining the heat. That we mark the equalization to occur on August 22 instead of August 3 is evidence, therefore, of an atmosphere, and of an atmosphere of some practical effect. We may note— after the fact, in consequence of Martian suggestion on the point—something of the same generality in our own coming-on of winter, when snowfalls occur over large latitudinal extents, though owing to our more extensive permanent caps and to our lack of sufficient knowledge of our arctic and antarctic regions, the fact has escaped significant notice.

The greater length of the Martian year intensifies the heat received in the arctic regions as compared with our own, and the less amount of deposition there further conduces to a like end. In consequence the arctic and antarctic regions of Mars are actually warmer in their summer than are ours, although the mean temperature of the planet, 48° F. (see papers by the writer in the Proceedings of the American Academy for March, 1907, and the Philosophical Magazine, London, 1907,) is less than ours (60° F.).

Lowell Observatory,
Bulletin No. 30.
June 22, 1907.

THE COMETS OF THE YEAR 1906.

H. KREUTZ.*

Comet 1905 *c* (1906 I). Compare V. S. J. 41 p. 77. The comet was seen for the last time before perihelion low on the horizon January 14, 1906 at the observatories in Utrecht, Strassburg, and Bamberg. According to Wirtz the brilliancy reached on that day 2.5^m., consequently with regard to "extinction" 0.7^m; in the coma of one minute diameter was to be distinguished a bright ninth magnitude nucleus; also the existence of two short tails could be noted in the bright twilight.

* Abstract from "Vierteljahrsschrift der Astronomischen Gesellschaft," 42 Jahr, 1 Heft.

After the perihelion observations were renewed in the southern hemisphere, February 5, at the Cape of Good Hope and in the northern hemisphere, February 15 at Washington. The fading of the brightness, already quite noticeable at this time, increased rapidly; Wirtz in Strassburg, February 22 estimated the comet as of the ninth magnitude, March 13 as of only the thirteenth magnitude. The last determination of position dates from Washington March 22. Duncan at Flagstaff and Barnard at Williams Bay obtained numerous photographs of the comet, principally during the time before perihelion; the photographs furnish very interesting particulars about the formation of the tail, which on the plates reached a length of ten degrees at the beginning of January 1906. On this point see Lowell Observatory Bulletin, No. 25 and the Astrophysical Journal 24 p. 255. At the Lick Observatory the comet was also photographed several times, but the plates are not yet worked out in detail (Publ. A. S. P. 18 p. 83). Schönberg and Büss derived from six normal places from December 7, 1905 to January 14, 1906 the following elements of the comet:

$$\left.\begin{array}{rl} T = & 1906\ \text{Jan. } 22.39266 \text{ m. t. B.} \\ \omega = & 199^\circ\ 11'\ 40''.0 \\ \Omega = & 92\ \ 5\ \ 5\ .7 \\ i = & 43\ \ 39\ \ 39\ .0 \end{array}\right\} 1906.0$$
$$\log q = 9.334268.$$

Comet 1906 *a* (1905 VI). This comet was discovered by Brooks at Geneva, N. Y., January 26, 1906, thirty-five days after its passage through perihelion, in 16^h and $+47^\circ$; it was a round nebula of the ninth magnitude, 8′ in diameter. There was a faint nucleus. The comet drew near, rising in north declination to 85°, when nearest to the Earth, so that it almost retained its first brilliancy until in the third week in February. Then it rapidly grew dimmer and by the end of February it had sunk to the tenth and by the end of March to the thirteenth magnitude. The last observation was taken April 24 at the Lowell Observatory at Flagstaff. The following elements were derived by Ebell, January 27, February 3 and 10, 1906.

$$\left.\begin{array}{rl} T = & 1905\ \text{Dec. } 22.2239 \text{ m.t.B.} \\ \omega = & 89^\circ\ 43'\ 47''.3 \\ \Omega = & 286\ \ 22\ \ 1\ .7 \\ i = & 126\ \ 27\ \ 33\ .2 \end{array}\right\} 1906.0$$
$$\log q = 0.112424.$$

Comet 1906 *b* (1905 IV) was photographically discovered by Kopff in Heidelberg, March 3, 1906, as a well-defined, little coma with a definite nucleus and a tail one-half a degree long. Visually

the brightness was of the eleventh magnitude, the nucleus 11.5,^{m} the diameter of the coma was about 40″ and with no tail visible to the eye. From March 17 to about the middle of May a very considerable change in the appearance of the comet took place. The observers with telescopes of moderate size saw, as a fan-shaped emanation developed from the nucleus toward the Sun, a phenomenon which was recognized in the 40-inch telescope of Yerkes Observatory by Barnard, as the formation of a second nucleus which was joined to the brighter principal nucleus by a faint bridge. Barnard measured the distance between the two nuclei on March 24 at 4.″7, on March 31 at 5.″7; any possible later measurements have not been published yet. After the middle of May in the Strassburg refractor the comet again appeared roundish, with a central nucleus as before. Since the perihelion had been passed five months before the discovery, the brilliancy was constantly although slowly decreasing. Wirtz in Strassburg estimated the comet May 10 at only 12.5^m, June 12 at 13.5^m; the last observation was at the Lick Observatory June 22.

By the aid of an ephemeris by Ebell, Wolf of Heidelberg also found the comet registered as an object of twelfth magnitude on one of his photographic plates taken January 14, 1905, i.e., 413 days before its discovery. E. Weiss has notified the observatories to look for the comet also in the next three months, February to April, 1907. Unfortunately the southern declination,—21°, will render any possible photographic views difficult, at least in Europe. From the observations January 4, 1905, March 16, April 14 and May 27, 1906, E. Weiss has computed the following parabola:

$$\left.\begin{array}{rl} T = & 1905\ \text{Oct.}\ 18.0347\ \text{m.t.B.} \\ \omega = & 158°\ 39'\ 56.''1 \\ \Omega = & 342\ \ 18\ \ \ 2.\ \ 8 \\ i = & \ \ \ 4\ \ 16\ \ \ 9.\ \ 7 \end{array}\right\} 1907.0$$
$$\log q = 0.523556.$$

According to this the comet has for its perihelion distance 3.3, which is exceeded only by that of the comet 1729 with a distance of 4.0. Only four comets have up to this time reached a perihelion distance of over 2.5; besides the two named, 1904 I with $q = 2.7$ and 1903 II with $q = 2.8$.

Comet 1906 *c* (1906 II), discovered March 18, by Ross at Melbourne in the evening sky in 2^h and —8°, as a circular nebula of the eighth magnitude, 3′ diameter and a central condensation. The comet moved northward and passed the equator at the end of March; but the unfavorable position with reference to the Sun,

together with the rapid decrease in brightness caused by the increasing distance from the Earth and the Sun, prevented following the comet beyond April 3. The last observations were made on that day at Washington and Mount Hamilton.

Miss Lamson has derived the following elements from March 19 and 23 and April 2.

$$\begin{aligned} T &= 1906\ \text{Feb. } 20.97047\ \text{m.t.B.} \\ \omega &= 276^\circ\ 27'\ 7''.1 \\ \Omega &= 72\ \ 2\ 28\ .1 \quad 1906.0 \\ i &= 83\ 27\ 32\ .1 \\ \log q &= 6.859086. \end{aligned}$$

Finlay's Comet 1906 *d* (1906 . . . .). Schulhof furnished in advance the following calculation for the very favorable appearance last year of Finlay's comet; the comet approached the Earth up to 0.27 and attained twenty-six times its brilliancy at the time of its discovery in the year 1886.

Epoch 1906 Aug. 1.0 m.t.B.

$$\begin{aligned} M &= 354^\circ\ 23'\ 2''.4 & \mu &= 542''.557 \\ \omega &= 315\ 48\ 17\ .5 & \log a &= 0.543707 \\ \Omega &= 52\ 22\ 37\ .7 \quad 1906.0 & T &= 1906\ \text{Sept. } 7.325\ \text{B.} \\ i &= 3\ \ 3\ \ 5\ .5 & U &= 6.^s54. \\ \phi &= 46\ 23\ 22\ .9 \end{aligned}$$

By means of Schulhof's ephemeris the comet was found July 16, and later also on a plate of July 14, by Kopff in Heidelberg, at a very considerable distance from the calculated position, a distance going far beyond the presumable uncertainty of the computations. The perihelion took place 1.05 days later than had been expected, and the computer has not yet been able to give any reason for this deviation. A hasty revision of the computation of the perturbations showed no serious errors, and consequently it almost looks as if some irregularity had taken place in the comet's course. In its brilliancy the comet met the expectations which could be founded upon the favorable opposition. At first of ninth magnitude, it increased in brightness until the middle of August, yet without ever becoming visible to the naked eye. After this time a slow steady decrease was evident and this made it impossible to follow the comet with medium-sized telescopes after the middle of November, when it had reached the thirteenth magnitude. It is not known at this time how much longer it was visible in the great telescopes. Judging from its brightness as compared with that at its first appearance in 1886-7 one would think that observations might be possible until the end of March. As to its appearance the comet was until the end of August a roughly-round nebulosity of 12′ diam-

eter with a faintly-marked condensation like a nucleus; no tail was recognized.

Comet 1906 *e* (1906 . . .) (Kopff), was found photographically in Heidelberg by Kopff, August 22, in 23^h and $+10°$. Later the discoverer also found it on a "Unarplatte," of August 20. At first the comet resembled a round haze of eleventh to twelfth magnitude with a diameter of one and one-half minutes of arc and a little nucleus of thirteenth magnitude. The brightness, however, decreased rather rapidly so that observations with a medium telescope had already come to an end in Strassburg by October 22; Wirtz reckoned the brightness on that day as 13.5. Later visual observations with great refractors are not yet reported but it is noteworthy and witnesses to the great light-power of the new 28-inch reflector at Königstuhl, that Wolf could still photograph the comet with this instrument on December 15 and 16, 1906, as an object of the sixteenth magnitude. From August 23 and 31 and September 12, 1906, Ebell has found the following elements:

Epoch 1906 Sept. 12.5 m.t.B.

$M = 19° 43' 18''.8$ $\mu = 536''.204$
$\omega = 19\ 33\ 44\ .3$ $\log a = 0.547118$
$\Omega = 263\ 48\ 45\ .3$ 1906.0 $T = 1906$ May 3.09 B.
$i = 8\ 42\ 8\ .4$ $U = 6.^s62.$
$\phi = 31\ 18\ 13\ .3$

There are also elements at hand found by Crawford and Champreux which from an almost equal interval of time yield a period of revolution of 6.67 years. According to this the comet is to be considered as another member of the class of periodic comets with short period.

Holmes' Comet, 1906 *f* (1906 III). The advance computations based upon the former appearances of Holmes' Comet by Zwiers led to the following elements:

Epoch 1906 Jan. 16.0 m.t.B.

$M = 351° 47' 11''.4$ $\mu = 517''.44766$
$\omega = 14\ 16\ 50\ .9$ $\log a = 0.557427$
$\Omega = 331\ 45\ 40\ .7$ 1906.0 $T = 1906$ March 14.22 B.
$i = 20\ 48\ 53\ .3$ $U = 6.^s86.$
$\phi = 24\ 20\ 25\ .6$

On the basis of this computation the comet was photographically found by Wolf in Heidelberg as an object of fifteenth to sixteenth magnitude. The error of the ephemeris amounted only to $6^s.9$, $+27''$, corresponding to a correction in the perihelion time of -0.09 days. Thus the advance computation founded upon two appearances proved to be extraordinarily exact. Wolf

obtained three impressions of the comet besides the one on the day of its discovery; these were on September 25, October 10 and December 7. Corresponding to the theoretical brilliancy, it was on both the first-named days somewhat brighter than on August 28, namely of the fifteenth magnitude, while it had again sunk to sixteenth magnitude by December 7. Aside from these four photographs no other observations are known. The comet was not visible at Strassburg at the time of its greatest theoretical brightness, October 22; as to whether this was the case with the great refractors we have no information up to this time. The comet was theoretically a little brighter than at the time when Perrine discovered it in 1899 at Lick Observatory; if it then really was not visible at this time with the great telescopes this would indicate a further important diminution of the comet's own light.

Comet 1906 *g* (1906 . . .) discovered by H. Thiele in Copenhagen November 10, 1906 in 9^h and $+12°$. The comet was a round coma of from eighth to ninth magnitude, 4′ in diameter with a condensation of tenth magnitude in the center. Since the perihelion took place on the 21st and the greatest proximity to the Earth on the 28th of November, the comet increased in brightness at first; as seen through an opera glass it was estimated at 7.7m. by Nijland November 17. After the middle of December a rather rapid decrease in light began, which has perhaps already led to the end of the observations (February 1). The last observation known to the writer dates from Rome, January 14, 1907. Dybeck has calculated the following parabola from November 19, December 17 and January 14:

$$\begin{aligned} T &= 1906\ \text{Nov. } 21.33709 \text{ m. t. B.} \\ \omega &= 8°\ 42'\ 44''.0 \\ \Omega &= 84\ \ 56\ \ 20\ \ .8 \quad 1907.0 \\ i &= 56\ \ 33\ \ 39\ \ .0 \\ \log q &= 0.084409. \end{aligned}$$

The elements leave a very considerable error in the middle place and it can not yet be said whether this results from inaccuracy in the observations or from the deviation of the orbit from a parabola.

Comet 1906 *h* (1906 . . .) (Metcalf), discovered photographically by Metcalf in Taunton, Massachusetts, November 14, 1906 in 4^h and $-2°$; the discovery plate is reproduced in POPULAR ASTRONOMY, Volume 15, Plate I. The comet was at first a round coma of eleventh to twelfth magnitude about 2′ in diameter with a distinct condensation in the center, but in consequence of

the increasing distance of the Earth and Sun it decreased rapidly in brightness so that by December 18 it was estimated by Wirtz in Strassburg at only magnitude thirteen. The observations in Strassburg went no further; it is not yet surely known whether the comet was observed later than this in other observatories, especially in those with large telescopes.

On November 22 Esclagon in Bordeaux found at a little distance from the comet two nebulous objects which were no longer visible on November 23; they may have been attendants of the comet, but also, as Esclagon himself indicates, they may ascribe their origin to the temporary penetration of water between the glasses of the objective. Compare on this point *A. N.* 173,159 and *C. R.* 143,870. This appearance was not seen in other places. The comet belongs, as does 1906 e to the class of comets with short period. The elements derived by Crawford from November 17, to December 5 and 18 run as follows:

Epoch 1906 Dec. 5.5 m. t. B.

$M = 7^\circ\ 16'\ 30.''8$
$\omega = 196\ 28\ 36\ .2$
$\Omega = 195\ 22\ 37\ .1$ 1906.0
$i = 14\ 53\ 57\ .3$
$\phi = 37\ 2\ 26\ .4$

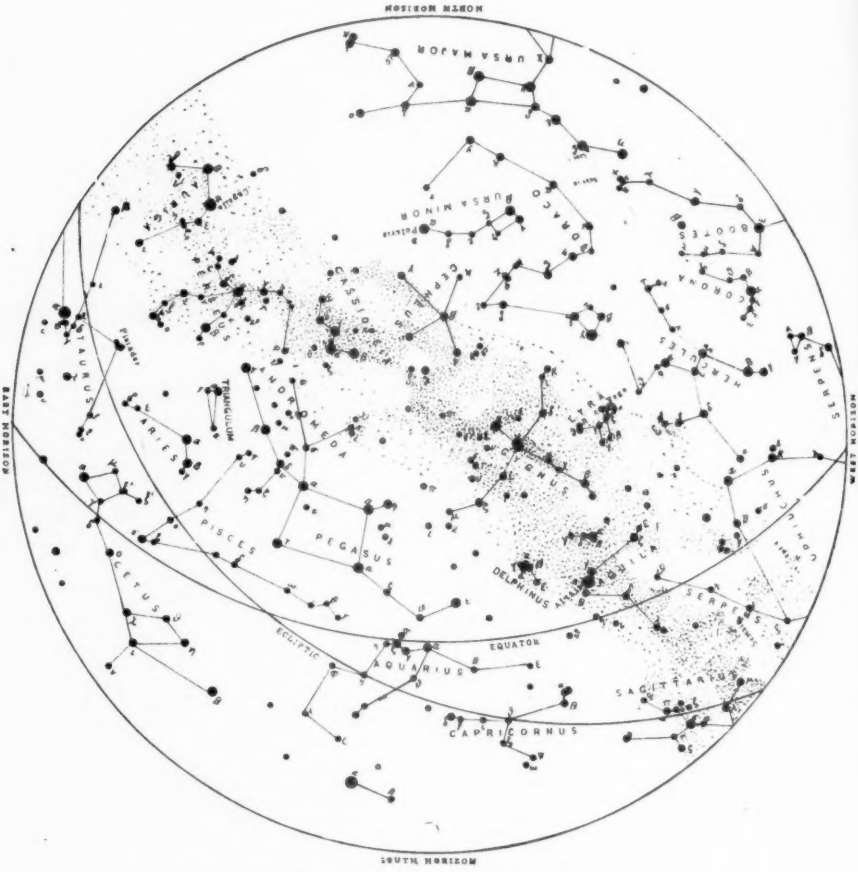
$\mu = 430''.736$
$\log a = 0.610531$
$T = 1906$ Oct. 5.695 B.
$U = 8.^s24.$

Kiel, Germany,
February 1, 1907.

[Translated from the German by Miss Isabella Watson, Carleton College, Northfield, Minnesota.]

PLANET NOTES FOR SEPTEMBER AND OCTOBER 1907.

H. C. WILSON.



THE CONSTELLATIONS AT 9:00 P. M., OCTOBER 1, 1907.

Mercury will be at superior conjunction on September 6, and so will not be visible during this month. In October the planet will be at greatest elongation, east from the Sun 24° 20′ on the 22nd, but its brilliancy then will not be very great, so that it will not be a conspicuous object as evening star.

Venus will also be at superior conjunction September 14, so that she will be invisible for this month. In the latter half of October she may be detected a little while after sunset near the WSW point of the horizon.

Mars has been a splendid object in the southern heavens during the summer months. It is now receding from us and decreasing rapidly in apparent diameter and brilliancy. Reports from the Lowell Observatory expedition to South America indicate that some of the "canals" of Mars have again been successfully photographed.

Jupiter is morning star and may be seen toward the ENE from two to three hours before sunrise. He is coming out rapidly from the morning twilight and by the end of October will be near the meridian at sunrise.

Saturn will be at opposition September 17, and is in splendid position for study during these months. The rings of Saturn are, however, almost exactly edgewise to us so that they will scarcely be visible to us. On September 1, the Earth will be 1° 10′ below the plane of the rings and on October 4 it will pass through that plane, attaining by October 31 an elevation of 0° 45′. Meanwhile the Sun will be shining on the lower side of the rings, at an angle of 0° 34′ on September 1 and 1° 28′ October 31. The satellites all revolving about the planet in planes nearly coincident with that of the rings will appear to move back and forth past the planet almost in straight lines about the first of October.

Uranus will be at quadrature, 90° east from the Sun, October 2 and so may be found, with the aid of a telescope, in the early evening. Its position is in the constellation Sagittarius about 5° northwest from the second magnitude star σ. On September 2 Mars will be about 1° directly south from the same star; but Mars will move toward the northeast from 20′ to 40′ daily while Uranus will remain almost stationary during September.

Neptune may be found in the morning in the constellation Gemini, but is not yet in very favorable position for study.

Occultations visible at Washington.

Date 1907	Star's Name	Magnitude.	IMMERSION. Washington M.T.		Angle from N.	EMERSION. Washington M.T.		Angle from N	Duration.	
			h	m	°	h	m	°	h	m
Sept. 14	ξ Ophiuchi	4.4	8	14	53	9	08	317	0	54
14	B.A.C. 5866	5.9	10	06	116	11	02	247	0	56
16	Piazzi xix, 61	5.5	6	23	20	6	52	338	0	29
20	ψ^3 Aquarii	5.2	6	47	23	7	31	297	0	44
20	B.A.C. 8214	6.5	16	54	12	17	27	300	0	33
26	BD. +17°, 750	6.2	10	55	42	11	51	277	0	56
26	Mayer 177	6.1	19	14	113	20	21	231	1	07
27	B.A.C. 1651	6.5	9	15	80	10	08	252	0	53
27	Piazzi v, 125	6.1	16	22	124	17	26	209	1	04
29	Neptune	...	12	12	40	12	55	306	0	43
Oct. 1	B.A.C. 2991	6.1	12	18	95	13	10	272	0	52
12	B.A.C. 6088	5.7	5	27	128	6	33	239	1	06
15	η Capricorni	4.8	4	47	115	5	50	222	1	03
21	85 Ceti	6.3	17	43	45	18	37	281	0	54
23	δ^3 Tauri	4.3	18	24	98	19	29	245	1	05
24	Mayer 198	6.3	10	44	48	11	50	272	1	09
24	107 Tauri	6.5	12	36	98	13	52	224	1	16
24	B.A.C. 1639	6.2	19	53	152	20	21	203	0	28
26	*d* Geminorum	5.2	11	57	125	12	49	217	0	52
28	39 Cancri	6.5	15	55	43	16	45	336	0	50
28	40 Cancri	6.5	15	52	55	16	57	324	1	05
28	B A.C. 2919	6.5	16	01	127	17	23	253	1	22
28	ε Cancri	6.3	16	33	169	17	07	212	0	36

Satellites of Saturn.

[The diagram of the orbits of the satellites cannot be shown since the Earth passes the planes of the orbits at different times during September and October.]
Central Standard Time reckoning from noon.

I Mimas. Period $0^d\ 22^h.6$.

	h		h		h		h
Sept. 1	13.8 E.	Sept. 16	15.6 E.	Oct. 3	14.6 E.	Oct. 20	13.7 E.
2	12.4 E.	17	14.2 E.	4	13.3 E.	21	12.3 E.
3	11.0 E.	18	12.8 E.	5	11.9 E.	22	10.9 E.
4	9.6 E.	19	11.4 E.	6	10.5 E.	23	4.6 E.
5	8.2 E.	20	10.0 E.	7	9.1 E.	24	8.2 E.
8	15.5 W.	21	8.6 E.	8	7.7 E.	25	6.8 E.
9	14.1 W.	25	14.6 W.	12	13.6 W.	29	12.7 W.
10	12.7 W.	26	13.2 W.	13	12.2 W.	30	11.3 W.
11	11.4 W.	27	11.8 W.	14	10.8 W.	31	9.9 W.
12	10.0 W.	28	10.4 W.	15	9.4 W.		
13	8.6 W.	29	9.0 W.	16	8.0 W.		

II Enceladus. Period $1^d\ 08^h.9$.

Sept. 1	3.2 E.	Sept. 16	4.8 E.	Oct. 1	6.5 E.	Oct. 16	8.1 E.
2	12.1 E.	17	13.7 E.	2	15.4 E.	17	17.0 E.
3	21.0 E.	18	22.6 E.	4	0.2 E.	19	1.9 E.
5	5.8 E.	20	7.5 E.	5	9.1 E.	20	10.8 E.
6	14.7 E.	21	16.3 E.	6	18.0 E.	21	19.7 E.
7	23.6 E.	23	1.2 E.	8	2.9 E.	23	4.6 E.
9	8.5 E.	24	10.1 E.	9	11.8 E.	24	13 4 E.
10	17.4 E.	25	19.0 E.	10	20.6 E.	25	22.3 E.
12	2.2 E.	27	3.9 E.	12	5.5 E.	27	7.2 E.
13	11.1 E.	28	12.7 E.	13	14.4 E.	28	16.1 E
14	20.0 E.	29	21.6 E.	14	23.3 E.	30	1.0 E.

III Tethys. Period $1^d\ 21^h.3$.

Sept. 2	18.6 E.	Sept. 15	23.7 E.	Oct. 1	2.0 E.	Oct. 16	4.4 E.
4	15.9 E.	17	21.0 E.	2	23.3 E.	18	1.7 E.
6	13.2 E.	19	18.3 E.	4	20.6 E.	19	23.0 E.
8	10.5 E.	21	15.6 E.	6	17.9 E.	21	20.3 E.
10	7.8 E.	23	12.9 E.	8	15.2 E.	23	17.6 E.
12	5.1 E.	25	10.2 E.	10	12.5 E.	25	14.9 E.
14	2.4 E.	27	7.4 E.	12	9.8 E.	27	12.2 E.
		29	4.7 E.	14	7.1 E.	29	9 5 E.

IV Dione. Period $2^d\ 17^h.7$.

Sept. 2	14.2 E.	Sept. 16	6.5 E.	Oct. 2	16.4 E.	Oct. 19	2.3 E.
5	7.8 E.	19	0.1 E.	5	10.0 E.	21	20.0 E.
8	1.5 E.	21	17.8 E.	8	3.7 E.	24	13.7 E.
10	19.1 E.	24	11.4 E.	10	21.3 E.	27	7.3 E.
13	12.8 E.	27	5.1 E.	13	15.0 E.	30	1.0 E.
		29	22.7 E.	16	8.7 E.		

V Rhea. Period $4^d\ 12^h.4$.

Sept. 1	10.8 E.	Sept. 19	12.1 E.	Oct. 3	1.1 E.	Oct. 21	2.5 E.
5	23.1 E.	24	0.4 E.	7	13.4 E.	25	14.8 E.
10	11.5 E.	28	12.8 E.	12	1.8 E.	30	3.2 E.
14	23.8 E.			16	14.1 E.		

VI Titan. Period $15^d\ 22^h.7$.

Sept. 3	1.6 I.	Sept. 18	23.1 I.	Oct. 4	20.7 I.	Oct. 20	18.4 I.
6	22.3 W.	22	19.9 W.	8	17.5 W.	24	15.3 W.
10	17.8 S.	26	15 4 S.	12	13.0 S.	28	10.9 S.
14	19.8 E.	30	17.3 E.	16	19.0 E.		

VII Hyperion. Period $21^d\ 06^h.6$.

Sept.	4.3 E.	Sept.	15.2 W	Oct.	1.8 I.	Oct.	16.8 E.
	10.5 I.		19.6 S.		6.4 W.		23.1 I.
			25.5 E.		10.8 S.		27.7 W.

VIII Iapetus.

Sept.	1.0 I.	Sept.	20.9 W.	Oct.	10.1 S.	Oct.	29.3 E.

COMET NOTES.

Comet *b* 1907 discovered independently by Grigg.—From *A. N.* 4175 we learn that the comet discovered by Mellish at Madison, Wisconsin, on April 14, was earlier discovered by Grigg at Thames, New Zealand, on April 9. From rough observations by Grigg April 9, 10 and 11, Mr. Merfield deduced the approximate elements:

$T = 1907$ March 26.35 Gr. M. T.
$\omega = 327° 01'$
$\Omega = 189\ 29$
$i = 94\ 53$
$q = 0.9178$

New Comet *c* 1907 (Giacobini).—A new comet was discovered by Giacobini, at the Nice Observatory, on June 1. It was then in Leo near the star ζ, and has since that time been moving southeastward through Leo and Virgo.

It was very faint when discovered and has been steadily diminishing in brightness so that it is now beyond the reach of the small telescopes.

The following elements were computed by Dr. E. Strömgren of Berlin from observations dated June 1, 5 and 8.

There is no ephemeris at hand for September.

$T = 1907$ May 31.2079 Berlin m. t.
$\omega = 39° 35.'12$
$\Omega = 160\ 52.\ 25$
$i = 14\ 50.\ 98$
$\log q = 0.09242$

The Discovery of Comet *d* 1907.—This comet was found on June 9, at $19^h\ 18^m$, G.M.T., with an old $5\frac{3}{4}$-inch comet seeker belonging to the Princeton Observatory. The approximate position obtained with the $9\frac{1}{2}$-inch equatorial was, $\alpha = 23^h\ 47^m\ 33^s$; $\delta = -1° 8'$.

Daylight occurred before motion could be proved. As there is no known nebula in this place, I immediately telegraphed it to Harvard College Observatory as a suspected comet. Clouds prevented further observation till June 12, when I obtained another position and found that the daily motion was $2^m\ 38^s$ east and 14′ north.

At discovery the comet was a conspicuous object in the 3-inch finder. In the $9\frac{1}{2}$-inch telescope, it appeared almost round with a central condensation and a faint stellar nucleus. On July 4, it was considerably brighter and had a prominent nucleus and a short tail. On July 12, it was easily visible to the naked eye as a star between the fourth and fifth magnitudes. With the comet seeker, the tail could be traced about 1°. On July 14, it was nearly equal to ξ^1 Ceti (Potsdam mag. 4.70). A narrow tail 1° or more in length was seen with a field glass.

ZACCHEUS DANIEL.

Princeton University.
Princeton, N. J.
July 16, 1907.

Comet *d* 1907 (Daniel.) Under date of July 8, William R. Brooks writes from Smith Observatory, Geneva, New York: "This comet suspected by Zaccheus Daniel at Princeton on June 9, was confirmed by the writer on June 11 at this

Observatory. Its position at that time was R.A. $23^h\ 53^m\ 10^s + 0°\ 40'$ and was moving slowly in a northeasterly direction. It was an easy object in the 10-inch refractor, and visible in the three-inch finder. The comet is rapidly growing brighter, and is now three times the brightness at confirmation, and must soon become visible to the naked eye.

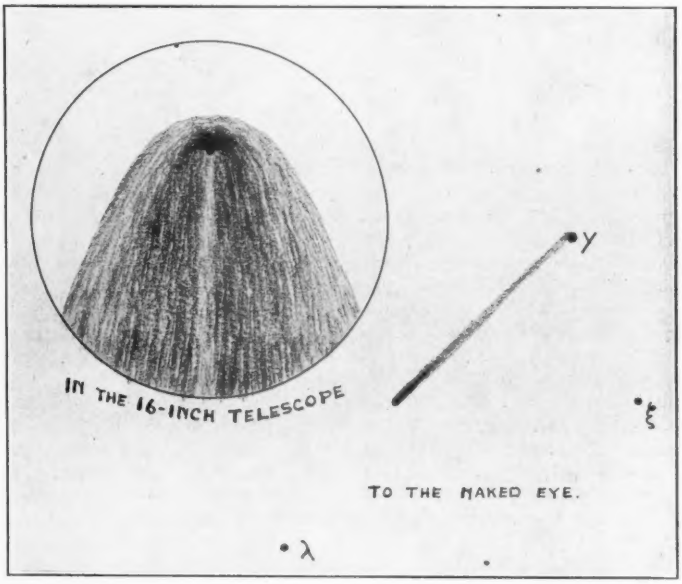
Its position this morning was R.A. $1^h\ 29^m\ 50^s + 7°\ 00'$.

The comet is large, nearly round, with a marked central condensation, in fact almost stellar this morning.

The departure from the round shape mentioned above, is no doubt the beginning of the formation of a tail which will probably become conspicuous before perihelion passage."

July tenth he added: "The comet was detected with the naked eye this morning as a misty star of about the fifth magnitude, the sky being very clear for this section. In the 10-inch telescope a tail was easily traced to 1½ degrees in length, and was also visible in the 3-inch finder."

New Comet *d* 1907 (Daniel).—On June 9 (morning of June 10) Mr. Zaccheus Daniel, of the Princeton Observatory, discovered a bright object in the constellation Pisces, which he suspected to be comet, but did not have time to verify by its motion. It was at once announced and the motion exhibited on the



SKETCH OF COMET *d* 1907 BY H. C. WILSON, AUG. 16, 1907.

next day confirmed its cometary character. It was then just below the limit of vision to the naked eye; but has since that time increased rapidly in brightness developed a considerable tail, so that now (August 17) it is a conspicuous object in the eastern sky in the morning. One should look for it due east at about four o'clock in the morning.

The comet's course has been eastward, only a little below the ecliptic, through the constellations Pisces, Aries, Taurus and Gemini. On September 1 it will be in the southern part of Cancer, south and a little east from the Praesepe cluster.

Elements have come to hand from several computers. Probably the best so far received are the following by Mr. Georg Dybeck, of Breslau, given in *A. N.* 4194:

$$\begin{aligned} T &= 1907 \text{ Sept. } 4.02390 \text{ Berlin m. t.} \\ \omega &= 294^\circ\ 14'\ 18'' \\ \Omega &= 143\ \ 0\ 51 \\ i &= \ \ 8\ 57\ 22 \end{aligned} \Big\} 1907.0$$

$$\log q = 9.711309$$

Coördinates from the Equator 1907.0

$$\begin{aligned} x &= [9.998087]\ r \sin (v + 167^\circ\ 35'\ 23'') \\ y &= [9.982399]\ r \sin (v + \ 79\ \ 09\ \ 23\ \ ) \\ z &= [9.468843]\ r \sin (v + \ 59\ \ 48\ \ 17\ \ ). \end{aligned}$$

According to these elements the comet will attain its maximum theoretical brightness about August 23, when it will be 20.6 times as bright as at the date of discovery.

Ephemeris of Comet *d* 1907.

[From *A. N.* 4194 Computed by Georg Dybeck.]

Berlin Midnight	True α h m s	True δ ° ′ ″	log *r*	log Δ	Brightness
Aug. 2	4 41 34.5	+16 27 19	9.9518	9.8798	13.89
4	5 0 29.0	16 50 39			
6	5 19 26.8	17 07 43	9.9193	9.8844	15.87
8	5 38 18.0	17 18 27			
10	5 56 55.8	17 22 56	9.8829	8.8972	17.60
12	6 15 12.5	17 21 29			
14	6 33 00.8	17 14 40	9.8462	9.9173	19.01
16	6 50 18.9	17 02 46			
18	7 07 05.8	16 46 58	9.8091	9.9431	20.03
20	7 23 19.2	16 27 22			
22	7 39 01.5	16 04 27	9.7736	9.9728	20.56
24	7 54 13.5	15 38 43			
26	8 08 57.8	15 10 39	9.7428	0.0047	20.46
28	8 23 16.8	14 40 32			
30	8 37 12.0	14 08 30	9.7207	0.0373	19.94
Sept. 1	8 50 44.9	+13 34 39			

Finding Ephemerides for Comet 1894 IV (E. Swift.) Comet 1894 IV is an object of unusual interest on account of its possible identity with the lost comet of DeVico which has not been seen since its appearance in 1844. It belongs to the Jupiter family of short-period comets, and has been subject at various times to perturbations of unusual magnitude as a result of the fact that its aphelion point lies close to the orbit of Jupiter.

The observations made during the apparition of 1894 extend from 1894, November 21, to 1895, January 29, and cover a geocentric arc of three hours in right ascension and twenty-two degrees in declination. The corresponding heliocentric motion in the orbit was only thirty-nine degrees. Definitive elements based upon these observations were published in A. N. 3606. The perturbations produced by Jupiter, Saturn, Earth, and Mars during the interval 1894-1900 were calculated by the method of variation of the constants and printed in A. N.

3656. During 1897 the comet was within one-half an astronomical unit of distance from Jupiter for over six months' time. The resulting disturbances in the orbit were very large, the period, for example, being changed by as much as six months. The comet was due to return to perihelion about February 13, 1901, but the conditions for its rediscovery were extremely unfavorable. The maximum theoretical light at this time was only 0.12 of that at the date of discovery in 1894, and less, indeed, than the brightness when the comet passed beyond the limit of vision of the 36-inch refractor at Mt. Hamilton in January, 1895. It is not surprising, therefore, that it was not found at this time. During the years 1900-1907, it has constantly been at a considerable distance from both Mars and Jupiter, and, as there is no other planet which can seriously disturb its orbit, the perturbations during the past seven years have been quite secondary in character. The present osculating orbit must, therefore, be nearly the same as that of 1900.

At the present writing the comet is again near perihelion, and, so far as position is concerned, is much more favorably situated for observation than it was in 1900-1901. On the other hand the only information we have concerning the orbit has been derived from the comparatively short arc observed thirteen years ago. The definitive elements themselves are therefore somewhat uncertain, and this in turn introduces a further uncertainty as to the exact amount of the large perturbations of 1897. Discovery during the present return may, in consequence, be a very difficult matter. Under the existing conditions the mean daily motion is the most uncertain element, and this is precisely the one which should be known with some precision in order to insure a rediscovery. It is possible, however, that the relatively favorable location with respect to the Earth may counteract, in a measure, the considerable uncertainty in position. The indications are that, when nearest the Earth, the comet will be nearly, if not quite, as bright as when it was discovered in 1894; and, in view of the fact that it was seen during this apparition, and actually observed, upon one occasion at least, in a 9-inch refractor, its discovery during the next few weeks is by no means an impossibility. All this of course, assumes that no unfavorable change in the intrinsic brilliancy of the object has taken place in the meantime.

It is therefore desirable that a systematic and careful search be made by those who have the proper equipment at their disposal. This is the more important in that a final answer to the question as to identity with the comet of DeVico depends upon its observation at the present return, for the elements of both comets DeVico and Swift are too uncertain for a successful bridging of the gap of fifty years which separates their appearances. And, at the same time, it is not likely that Swift's comet will be seen at any future return, except by accident, unless it is found during the next few months. It is only in this way that the periodic time can be determined with sufficient precision to trace back with certainty the changes which occurred in the orbit during the half century preceding the apparition of 1894 and to predict its motion for the future with any approximation to accuracy.

The ephemeris given in columns one to four of the table is based upon the following osculating elements taken from A. N. 3656. With the exception of a correction* in notation and a transfer to the equinox of 1907.0 no change has been made.

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* In A. N. 3656, p. 129, the element designated by M should have been printed as L.

EPOCH AND OSCULATION 1900, July 23.0 B. M. T.

$$\left.\begin{array}{rl} L = & 317^\circ\ 16'.2 \\ \varpi = & 349\ \ 2\ .8 \\ \Omega = & 24\ 56\ .5 \\ i = & 3\ 35\ .0 \\ \phi = & 31\ \ 2\ .5 \\ \mu = & 554''.3823 \end{array}\right\} \quad 1907.0$$

It would have been better to have used elements free from the perturbations of the years 1900-1907, but for various reasons it has not been possible to carry through the calculation necessary for the determination of these disturbances. It is not likely, however, that any real accuracy would have been gained for the ephemeris by this procedure, for the uncertainty introduced into the predicted positions through the neglect of these perturbations is, in all probability, less than that arising from the inaccuracies in the original definitive elements and in the large perturbations of the year 1897.

B. M. T.		R. A. h m	Dec. ° ′	Br.	R. A. h m	Dec. ° ′	Br.
1907 July	8.5	1 34.9	+ 7 17	0.42	1 3.7	+ 3 15	0.48
	12.5	43.8	8 14		12.2	4 12	
	16.5	1 52.5	9 9	0.45	20.5	5 8	0.54
	20.5	2 1.1	10 2		28.7	6 1	
	24.5	9.5	10 53	0.48	36.6	6 53	0.61
	28.5	17.7	11 43		44.3	7 43	
Aug.	1.5	25.7	12 31	0.51	51.7	8 31	0.68
	5.5	33.5	13 17		1 58.9	9 17	
	9.5	40.9	14 0	0.54	2 5.7	10 1	0.74
	13.5	48.0	14 41		12.1	10 43	
	17.5	2 54.7	15 20	0.58	18.1	11 23	0.80
	21.5	3 1.1	15 57		23.6	12 1	
	25.5	7.1	16 31	0.61	28.7	12 36	0.86
	29.5	12.6	17 3		33.3	13 9	
Sept.	2.5	17.6	17 34	0.64	37.3	13 40	0.92
	6.5	22.1	18 2		40.7	14 8	
	10.5	26.0	18 29	0.67	43.6	14 34	0.97
	14.5	29.3	18 53		45.8	14 57	
	18.5	32.1	19 15	0.70	47.3	15 18	1.01
	22.5	34.1	19 35		48.3	15 36	
	26.5	35.6	19 53	0.72	48.5	15 52	1.05
	30.5	36.3	20 10		48.0	16 5	
Oct.	4.5	36.4	20 24	0.73	46.9	16 16	1.05
	8.5	35.8	20 36		45.1	16 24	
	12.5	34.5	20 46	0.73	42.9	16 30	1.03
	16.5	32.7	20 53		40.3	16 34	
	20.5	30.3	20 58	0.72	37.5	16 36	0.98
	24.5	27.3	21 1		34.3	16 36	
	28.5	24.0	21 2	0.69	31.1	16 35	0.91
Nov.	1.5	20.3	21 0		27.7	16 32	
	5.5	16.5	20 57	0.64	24.5	16 29	0.81
	9.5	12.7	20 53		21.3	16 25	
	13.5	8.9	20 48	0.58	18.5	16 21	0.71
	17.5	5.3	20 42		16.2	16 18	
	21.5	3 2.0	+20 34	0.50	2 14.3	+16 15	0.60

Brightness, 1894, Nov. 21 = 1.00

The constants to the equator for the year 1907.0 are:

$$x = r\,[9.9999]\ \sin\ (\ 79^\circ\ \ 0' + v)$$
$$y = r\,[9.9511]\ \sin\ (349\ \ 46 + v)$$
$$z = r\,[9.6532]\ \sin\ (346\ \ 0 + v)$$

The elements given above indicate a perihelion passage for 1907, July 9. For

that date the logarithm of the geocentric distance was 0.1745 and the brightness 0.42 of that at the time of discovery in 1894. The geocentric distance decreases until about October 20, upon which date the logarithm is 9.9942. The decrease in this quantity more than offsets the increasing distance of the comet from the Sun, so that the calculated brightness increases until about October 8.

In order to exhibit the effect of an uncertainty in the mean daily motion, a second series of positions was computed on the assumption that the perihelion passage will not occur until July 25. The results are in columns five to seven of the table. This variation of sixteen days in the date of perihelion corresponds to a difference of about two seconds of arc in the mean daily motion when distributed over the entire interval 1894-1907. It will be observed that such a delay would bring the comet into even more favorable position with respect to the Earth than is indicated by the elements printed above. Under this assumption the logarithm of the minimum geocentric distance is 9.9388, a value which should be attained about October 12.

In conclusion, it is of interest to note that the present position of Swift's comet is apparently close to that of the comet *d* 1907 (Daniel) as shown by calculations made at the Student's Observatory of the University of California and distributed in *Lick Observatory Bulletin* No. 119. The elements given for the latter object seem to preclude, however, any possibility of identity between the two comets.

F. H. Seares.

Columbia, Missouri, 1907, July 10.
Laws Observatory Bulletin, No. 12.

VARIABLE STARS.

Approximate Magnitudes of Variable Stars on Aug. 1, 1907.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h	m	Decl. 1900. °	′	Magn.	Name.	R. A 1900 h	m	Decl. 1900 °	′	Magn.
T Androm.	0	17.2	+26	26	11.5*d*	RV Virginis	13	2.7	−12	38	<13.5
T Cassiop.		17.8	+55	14	7.5 *i*	V Virginis		22.6	− 2	39	9.8*d*
R Androm.		18.8	+38	1	7.0 *i*	R Hydrae		24.2	−22	46	4.0
S Cassiop.	1	12.3	+72	5	14.5*d*	S Virginis		27.8	− 6	41	10.5 *i*
S Persei		15.7	+58	8	9.5	T Urs.Min.		32.6	+73	56	<13
T Camelop.	4	30.4	+65	57	12.2*d*	R Can. Ven.		44.6	+40	2	12.0
X Camelop.		32.6	+74	56	12.5*d*	RR Virginis		59.6	− 8	43	<14
R Aurigae	5	9.2	+53	28	12 *i*	Z Bootis	14	1.7	+13	59	8.2 *i*
S Camelop.		30.2	+68	45	8.5	Z Virginis		5.0	−12	50	12 8*d*
S Lyncis	6	35.9	+58	0	12 *i*	S Bootis		19.5	+54	16	9.0 *i*
R Lyncis		53.0	+55	28	13.5	RS Virginis		22.3	+ 5	8	12.0 *i*
Y Draconis	9	31.1	+78	18	8.8 *i*	V Bootis		25.7	+39	18	9.6*d*
R Leo. Min.		39.6	+34	58	13.4*d*	R Camelop.		25.1	+84	17	9.0*d*
R Leonis		42.2	+11	54	9.6*d*	R Bootis		32.8	+27	10	10.7*d*
V Leonis		54.5	+21	44	9.8 *i*	V Librae		34.8	−17	14	10.2*d*
R Urs. Maj.	10	37.6	+69	18	13.2*d*	U Bootis		49.7	+18	6	11.6*d*
W Leonis		48.4	+14	15	10.6 *i*	RT Librae	15	0.8	−18	21	11.4 *i*
R Comae	11	59.1	+19	20	7.8*d*	T Librae		5.0	−19	38	11.0 *i*
T Virginis	12	9.5	− 5	29	11.0 *i*	Y Librae		6.4	− 5	38	13.5*d*
T Can.Ven.		25.2	+32	3	8.4 *i*	S Librae		15.6	−20	2	8.4 *i*
T Urs. Maj.		31.8	+60	2	10.6*d*	S Serpentis		17.0	+14	40	9.0 *i*
R Virginis		33.4	+ 7	32	10.3 *i*	S Coronae		17.3	+31	44	10.6*d*
RS Urs. Maj.		34.4	+59	2	10.0*d*	RS Librae		18.5	−22	33	10.0*d*
S Urs. Maj.		39.6	+61	38	8.2*d*	RU Librae		27.7	−14	59	9.0 *i*
RU Virginis		42.2	+ 4	42	9.0*d*	X Librae		30.4	−20	50	13.2*d*
U Virginis		46.0	+ 6	6	13.5*d*	W Librae		32.2	−15	51	<13
RT Virginis		57.6	+ 5	43	9.0*d*	S Urs.Min.		33.4	+78	58	8.3 *i*

Approximate Magnitudes of Variable Stars on Aug. 1, 1907—Con.

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900. h m	Decl. 1900. ° ′	Magn.
U Librae	15 36.2	−20 52	10.2 *i*	RW Sagittarii	19 8.1	−19 2	9.0
Z Librae	40.7	−20 49	10.8 *i*	S Lyrae	9.1	+25 50	<13.5
R Coronae	44.4	+28 28	6.0	RS Lyrae	9.3	+33 15	<13.5
X Coronae	45.2	+36 35	12	RU Lyrae	9.1	+41 8	12 *i*
R Serpentis	46.1	+15 26	6.6*d*	U Draconis	9.9	+67 7	8.8 *i*
V Coronæ	46.0	+39 52	10.4*d*	W Aquilae	10.0	− 7 13	13.0
R Librae	47.9	−15 56	<13	T Sagittae	10.5	−17 9	8.0
RR Librae	50.6	−18 1	12.2*d*	R Sagittae	10.8	−19 29	11.0
RZ Scorpii	58.6	−23 50	12.5*d*	S Sagittae	13.6	−19 12	12.5
Z Scorpii	16 0.1	−21 28	9.0*d*	TZ Cygni	13.4	+50 0	10.6
R Herculis	1.7	+18 38	11.8*d*	U Lyrae	16.6	+37 42	12.6
RR Herculis	1.5	+50 46	9.0	T Sagittae	17.2	+17 28	9.2 *i*
U Serpentis	2.5	+10 12	9.6 *i*	TY Cygni	29.8	+28 6	10.5
X Scorpii	2.7	−21 16	13 *d*	R Cygni	34.1	+49 58	9.8*d*
W Scorpii	5.9	−19 53	<14	RT Cygni	40.8	+48 32	8.8*d*
RX Scorpii	5.9	−24 38	13 *d*	TU Cygni	43.3	+48 49	11.5
RU Herculis	6.0	+25 20	8.0	X Aquilae	46.5	+ 4 13	11.8
R Scorpii	11.7	−22 42	14.4*d*	X Cygni	46.7	+32 40	10.5*d*
S Scorpii	11.7	−22 39	10.0 *i*	RR Aquilae	52.4	− 2 11	11.2*d*
W Coronae	11.8	+38 3	12.2*d*	RS Aquilae	53.7	− 8 9	14.0
W Ophiuchi	16.0	− 7 28	9.7*d*	Z Cygni	58.6	+49 46	12.8*d*
U Herculis	21.4	+19 7	7.8 *i*	S Cygni	20 3.4	+57 42	<14
Y Scorpii	23.8	−19 13	11.0	RS Cygni	9.8	+38 28	8.6*d*
SS Herculis	28.0	+ 7 3	9.6 *i*	R Delphini	10.1	+ 8 47	9.0
S Ophiuchi	28.5	−16 57	12.2*d*	U Cygni	16.5	+47 35	9.3*d*
T Ophiuchi	28.0	−15 55	13.2*d*	RW Cygni	25.2	+39 39	8.6
W Herculis	31.7	+37 32	14.0*d*	RU Capric.	26.7	−22 2	<12
R Draconis	32.4	+66 58	7.5 *i*	S Delphini	38.5	+16 44	11.0
RR Ophiuchi	43.2	−19 17	9.2 *i*	V Cygni	38.1	+47 47	8.0 *i*
S Herculis	47.4	+15 7	11.8*d*	Y Aquarii	39.2	− 5 12	<12
RV Herculis	56.8	+31 22	12.4 *i*	T Delphini	40.7	+16 2	11.0*d*
R Ophiuchi	17 2.0	−15 58	13.0*d*	V Aquarii	41.8	+ 2 4	8.2
RT Herculis	6.8	+27 11	12.6*d*	T Aquarii	44.7	− 5 31	10.4*d*
RS Herculis	17.5	+23 1	8.2 *i*	X Capric.	21 2.8	−21 45	<12
RS Ophiuchi	44.8	− 6 40	11.0 *i*	X Cephei	3.6	+82 40	<13
RT Ophiuchi	51.8	+11 11	10.2 *i*	RS Aquarii	5.8	− 4 27	<12
Z Ophiuchi	14.5	+ 1 37	9.6 *i*	Z Capricorni	5.0	−16 35	<12
T Draconis	54.8	+58 14	10.4 *i*	T Cephei	8.2	+68 5	5.5
RY Herculis	55.4	+19 29	9.0*d*	RR Aquarii	9.8	− 3 19	<12
V Draconis	56.3	+54 53	11.5*d*	S Cephei	36.5	+78 10	10.0
T Herculis	18 5.3	+31 0	8.0	RU Cygni	37.3	+53 52	8.5*d*
W Lyrae	11.5	+36 38	7.0 *i*	T Pegasi	22 4.0	+12 3	<12
T Serpentis	23.9	+ 6 14	12.5 *i*	Y Pegasi	6.8	+13 52	11.4
RZ Herculis	32.7	+25 28	11.4 *i*	RS Pegasi	7.4	+14 4	<12
X Ophiuchi	33.6	+ 8 44	7.3	RT Aquarii	17.7	−22 34	9.0
RY Lyrae	41.2	+34 34	14.0*d*	S Aquarii	51.8	−20 53	8.6
Z Lyrae	56.0	+34 49	14.0	RW Pegasi	59.2	+14 46	9.2
RX Lyrae	50.4	+32 42	14.0	R Pegasi	23 1.6	+10 0	10.5
ST Sagittarii	55.9	−12 54	13.5	W Pegasi	14.8	+25 44	12.0
RT Lyrae	57.8	+37 22	13.5	R Aquarii	38.6	−15 50	9.0
R Aquilae	19 1.6	+ 8 5	12.0	Z Cassiop.	39.7	+56 2	13.0*d*
V Lyrae	5.2	+29 30	<13.5	R Cassiop.	53.3	+50 50	7.6*i*
RX Sagittarii	8.7	−18 59	10.5*d*	Y Cassiop.	58.2	+55 7	13.0*d*

The letter *i* denotes that the light is increasing, the letter *d* that the light is decreasing, the sign <, that the variable is fainter than the appended magnitude.

The magnitudes given above have been compiled by Mr. Leon Campbell of the Harvard College Observatory, from observations made at the Vassar College, Whiteside, and Harvard Observatories.

Minima of Variable Stars of the Algol Type.

[Given to the nearest hour in Greenwich Mean Time beginning with noon. To reduce to Central Standard time subtract 6 hours, or for Eastern time subtract 5 hours. Alternate minima only are given except in the case of RX Cephei and UZ Cygni.]

U Cephei

	d	h
Sept.	5	11
	10	10
	15	10
	20	9
	25	9
	30	9
Oct.	5	8
	10	8
	15	8
	20	7
	25	7
	30	7

Z Persei

	d	h
Sept.	3	6
	9	9
	15	12
	21	15
	27	17
Oct.	3	20
	9	23
	16	2
	22	4
	28	7

RX Cephei

	d	h
Sept.	15	8
Oct.	17	16

Algol

	d	h
Sept.	2	0
	7	18
	13	11
	19	5
	24	22
	30	16
Oct.	6	10
	12	3
	17	21
	23	15
	29	8

RT Persei

	d	h
Sept.	1	21
	3	14
	5	6
	6	23
	8	16
	10	9
	12	2
	13	18
	15	11
	17	4
	18	21
	20	13
	22	6
	23	23
	25	16
	27	8
	29	1
	30	18

RT Persei

	d	h
Oct.	2	11
	4	4
	5	20
	7	13
	9	6
	10	23
	12	15
	14	8
	16	1
	17	18
	19	11
	21	3
	22	20
	24	13
	26	6
	27	22
	29	15
	31	8

λ Tauri

	d	h
Sept.	3	15
	11	13
	19	10
	27	8
Oct.	5	6
	13	4
	21	1
	28	23

RW Tauri

	d	h
Sept.	5	5
	10	17
	16	6
	21	19
	27	8
Oct.	2	21
	8	10
	13	23
	19	12
	25	1
	30	14

RW Persei

	d	h
Sept.	8	0
Oct.	4	10
	30	19

RS Cephei

	d	h
Sept.	5	14
	30	11
Oct.	25	7

RW Geminorum

	d	h
Sept.	2	6
	8	0
	13	17
	19	11
	25	5
	30	22
Oct.	6	16
	12	9

RW Geminorum

	d	h
Oct.	18	3
	23	20
	29	14

R Canis Maj.

	d	h
Sept.	1	20
	4	2
	6	9
	8	15
	10	22
	13	4
	15	11
	17	17
	20	0
	22	6
	24	13
	26	19
	29	2
Oct.	1	8
	3	15
	5	21
	8	4
	10	10
	12	17
	15	0
	17	6
	19	13
	21	19
	24	2
	26	8
	28	15
	30	21

Y Camelopardi

	d	h
Sept.	1	10
	8	1
	14	16
	21	6
	27	21
Oct.	4	12
	11	2
	17	17
	24	8
	30	22

RR Puppis

	d	h
Sept.	6	6
	19	3
Oct.	1	23
	14	20
	27	17

V Puppis

	d	h
Sept.	2	2
	5	0
	7	22
	10	19
	13	17
	16	15
	19	13
	22	11

V Puppis

	d	h
Sept.	25	8
	28	6
Oct.	1	4
	4	3
	7	0
	9	21
	12	19
	15	17
	18	15
	21	13
	24	11
	27	8
	30	6

X Carinæ

	d	h
Sept.	1	19
	3	23
	6	3
	8	7
	10	11
	12	15
	14	19
	16	23
	19	3
	21	7
	23	11
	25	15
	27	19
	29	23
Oct.	2	3
	4	7
	6	11
	8	15
	10	19
	12	23
	15	3
	17	7
	19	11
	21	15
	23	19
	25	23
	28	3
	30	7

S Cancri

	d	h
Sept.	7	7
	25	6
Oct.	15	5

S Velorum

	d	h
Sept.	2	19
	14	16
	26	13
Oct.	8	10
	20	7

RR Velorum

	d	h
Sept.	2	15
	6	8
	10	1
	13	18

RR Velorum

	d	h
Sept.	17	11
	21	4
	24	21
	28	14
Oct.	2	7
	6	0
	9	17
	13	10
	17	3
	20	20
	24	13
	28	6
	31	23

Z Draconis

	d	h
Sept.	2	6
	4	23
	7	17
	10	10
	13	3
	15	20
	18	13
	21	6
	24	0
	26	17
	29	10
Oct.	2	3
	4	20
	7	13
	10	6
	13	0
	15	17
	18	10
	21	3
	23	20
	26	13
	29	7

δ Libræ

	d	h
Sept.	1	15
	6	6
	10	22
	15	14
	20	6
	24	21
	29	13
Oct.	4	5
	8	20
	13	12
	18	4
	22	20
	27	11

U Coronæ

	d	h
Sept.	2	14
	9	12
	16	10
	23	7
	30	5

Minima of Variable Stars of the Algol Type.—Continued.

U Coronae		Z Herculis		SX Sagittarii		WW Cygni		VV Cygni	
d	h	d	h	d	h	d	h	d	h
Oct. 7	3	Oct. 20	16	Sept. 2	18	Oct. 11	14	Sept. 24	16
14	0	24	16	6	22	18	6	27	15
20	22	28	16	11	2	24	21	30	14
27	20	RS Sagittarii		15	5	31	12	Oct. 3	13
R Arae		Sept. 1	11	19	9	SW Cygni		6	12
Sept. 2	23	6	7	23	13	Sept. 4	11	9	11
11	20	11	3	27	16	13	15	12	9
20	16	15	23	Oct. 1	20	22	18	15	8
29	13	20	19	6	0	Oct. 1	22	18	7
Oct. 8	9	25	15	10	3	11	1	21	6
17	5	30	11	14	7	20	5	24	5
26	2	Oct. 5	7	18	11	29	8	27	4
U Ophiuchi		10	3	22	14	VW Cygni		30	3
Sept. 1	11	14	23	26	18	Sept. 4	23	UZ Cygni	
3	4	19	19	30	22	21	20	Sept. 7	10
4	20	24	15	RR Draconis		Oct. 8	16	Oct. 8	7
6	12	29	10	Sept. 3	5	25	13	RZ Cassiop.	
8	4	V Serpentis		8	21	UW Cygni		Sept. 1	7
9	21	Sept. 2	9	14	13	Sept. 4	6	3	16
11	13	9	6	20	5	11	3	6	1
13	5	16	4	25	21	18	1	8	11
14	21	23	2	Oct. 1	13	24	22	10	20
16	14	30	0	7	5	Oct. 1	20	13	6
18	6	Oct. 6	21	12	20	8	18	15	15
19	22	13	19	18	12	15	15	18	0
21	14	20	17	24	4	22	13	20	10
23	7	27	15	29	20	29	11	22	19
24	23	RX Herculis		RZ Ophiuchi		W Delphini		25	4
26	15	Sept. 1	10	Oct. 3	17	Sept. 3	21	27	14
28	7	3	5	RV Lyræ		13	11	29	23
30	0	5	0	Sept. 2	5	23	2	Oct. 2	8
Oct. 1	16	6	18	9	9	Oct. 2	17	4	18
3	8	8	13	16	14	12	8	7	3
5	1	10	8	23	19	21	22	9	13
6	17	12	3	Oct. 1	0	31	13	11	22
8	9	13	21	8	5	RR Delphini		14	7
10	1	15	16	15	9	Sept. 1	5	16	17
11	18	17	11	22	14	10	10	19	2
13	10	19	5	29	19	19	15	21	11
15	2	21	0	U Sagittæ		28	20	23	21
16	18	22	19	Sept. 1	2	Oct. 8	1	26	6
18	11	24	13	7	20	17	5	28	15
20	3	26	8	14	15	26	10	31	1
21	19	28	3	21	9	RV Capricorni		24.1907	
23	11	29	21	28	3	Sept. 1	10	Monoc.	
25	4	Oct. 1	16	Oct. 4	22	7	23	Sept. 2	18
26	20	3	11	11	16	14	11	6	14
28	12	5	5	18	10	20	23	10	9
30	4	7	0	25	4	27	11	14	5
31	21	8	19	31	23	Oct. 3	23	18	0
Z Herculis		10	14	SY Cygni		10	12	21	20
Sept. 2	18	12	8	Sept. 3	1	17	0	25	15
6	18	14	3	15	1	23	12	27	13
10	18	15	22	27	1	30	0	Oct. 1	9
14	18	17	16	Oct. 9	2	VV Cygni		5	4
18	18	19	11	21	2	Sept. 1	1	9	0
22	18	21	6	WW Cygni		4	0	12	19
26	17	23	0	Sept. 1	19	6	23	16	15
30	17	24	19	8	10	9	22	20	10
Oct. 4	17	26	14	15	1	12	20	24	6
8	17	28	8	21	16	15	19	28	1
12	17	30	3	28	8	18	18	31	21
16	16	31	22	Oct. 4	23	21	17		

Maxima of Variable Stars of Short Period not of the Algol Type.

Unless otherwise indicated the times of maxima only are given; and the times of minima may be found by subtracting the interval printed in parentheses under the names of the stars.

RW Cassiop.

	d	h
	(−5	19)
Sept.	13	2
	27	22
Oct.	12	17
	27	12

RX Aurigæ

	(−4	0)
Sept.	8	6
	19	21
Oct.	1	12
	13	3
	24	18

Y Aurigæ

	(−0	18)
Sept.	1	23
	5	19
	9	16
	13	12
	17	9
	21	6
	25	2
	28	23
Oct.	2	19
	6	16
	10	13
	14	9
	18	6
	22	3
	25	23
	29	20

T Monoc.

	(−7	23)
Sept.	26	8
Oct.	23	8

W Geminorum

	(−2	22)
Sept.	6	23
	14	21
	22	19
	30	17
Oct.	8	15
	16	13
	24	11

ζ Geminorum

	(−5	0)
Sept.	10	12
	20	16
	30	19
Oct.	10	23
	21	3
	31	7

V Carinæ

	(−2	4)
Sept.	6	8
	13	1
	19	17
	26	10

V Carinæ

	d	h
Oct.	3	3
	9	19
	16	12
	23	5
	29	21

T Velorum

	(−1	10)
Sept.	1	5
	5	21
	10	12
	15	3
	19	19
	24	10
	29	1
Oct.	3	17
	8	8
	12	23
	17	15
	22	6
	26	21
	31	13

W Carinæ

	(−1	0)
Sept	4	9
	8	18
	13	3
	17	12
	21	21
	26	6
	30	15
Oct.	5	0
	9	8
	13	17
	18	2
	22	11
	26	20
	31	5

S Muscæ

	(−3	11)
Sept.	1	1
	10	17
	20	9
	30	1
Oct.	9	16
	19	8
	29	0

T Crucis

	(−2	2)
Sept.	3	4
	9	22
	16	16
	23	9
	30	3
Oct.	6	20
	13	14
	20	7
	27	1

R Crucis

	d	h
	(−1	10)
Sept.	4	8
	10	3
	15	23
	21	19
	27	15
Oct.	3	11
	9	6
	15	2
	20	22
	26	18

S Crucis

	(−1	12)
Sept.	3	2
	7	19
	12	11
	17	4
	21	20
	26	13
Oct.	1	6
	5	22
	10	15
	15	7
	20	0
	24	16
	29	9

V Centauri

	(−1	11)
Sept.	2	22
	8	10
	13	22
	19	10
	25	22
	30	10
Oct.	5	22
	11	9
	16	21
	22	9
	27	21

R Triang. Austr.

	(−1	0)
Sept.	2	8
	5	17
	9	3
	12	12
	15	21
	19	7
	22	16
	26	1
	29	11
Oct.	2	20
	6	5
	9	15
	13	0
	16	9
	19	19
	23	4
	26	13
	29	23

S Triang. Austr

	d	h
	(−2	2)
Sept.	5	13
	11	21
	18	5
	24	12
	30	20
Oct.	7	4
	13	12
	19	19
	26	3

S Normæ

	(−4	10)
Sept.	9	10
	19	4
	28	22
Oct.	8	16
	18	10
	28	4

RV Scorpii

	(−1	10)
Sept.	5	19
	11	20
	17	22
	23	23
	30	1
Oct.	6	2
	12	4
	18	5
	24	7
	30	8

RV Ophiuchi Minimum

Sept.	2	12
	6	5
	9	21
	13	14
	17	6
	20	23
	24	15
	28	8
Oct.	2	0
	5	17
	9	9
	13	2
	16	18
	20	11
	24	3
	27	20
	31	12

X Sagittae

	(−2	22)
Sept.	5	16
	12	16
	19	16
	26	16
Oct.	3	17
	10	17
	17	17

X Sagittae

	d	h
Oct.	24	18
	31	18

Y Ophiuchi

	(−6	5)
Sept.	17	17
Oct.	4	20
	21	23

W Sagittarii

	(−3	0)
Sept.	7	0
	14	14
	22	5
	29	19
Oct.	7	9
	14	23
	23	14
	30	4

Y Sagittarii

	(−2	2)
Sept.	6	18
	12	12
	18	7
	24	2
	29	20
Oct.	5	15
	11	9
	17	4
	22	22
	28	17

U Sagittarii

	(−2	23)
Sept.	2	21
	9	15
	16	9
	23	3
	29	21
Oct.	6	14
	13	8
	20	2
	26	20

β Lyrae

	(−3	2)
	(−3	7)
Sept.	3	2
	9	18
	16	1
	22	17
	28	23
Oct.	5	15
	11	21
	18	13
	24	19
	31	11

κ Pavonis

	(−4	7)
Sept.	1	13
	10	15
	19	18

Maxima of Variable Stars of the Short Period not of Algol Type.

Continued.

κ Pavonis		U Vulpeculae		T Vulpeculae		RV Capricorni		XZ Cygni	
d	h	d	h	d	h	d	h	d	h
Sept. 28	20	Sept. 12	5	(−1	10)	Sept. 5	12	Oct. 4	0
Oct. 7	22	20	4	Sept. 1	3	7	7	8	17
17	0	28	4	5	13	9	2	13	17
26	2	Oct. 6	3	9	23	10	21	18	11
U Aquilae		14	3	14	10	12	16	23	11
(−2	4)	22	2	18	20	14	11	28	4
Sept. 7	7	30	2	23	7	16	6	δ Cephei	
14	8	SU Cygni		27	17	18	1	(−1	10)
21	9	(−1	7)	Oct. 2	4	19	20	Sept. 5	13
28	9	Sept. 2	14	6	14	21	15	10	21
Oct. 5	10	6	10	11	1	23	9	16	6
12	10	10	6	15	11	25	4	21	15
19	11	14	2	19	22	26	23	27	0
26	11	17	23	24	8	28	18	Oct. 2	9
XZ Cygni		21	19	28	18	30	13	7	18
(−0	4)	25	15	TX Cygni		Oct. 2	8	13	2
Period 11h		29	12	Sept. 4	10	4	3	18	11
Sept. 1	8	Oct. 3	8	19	3	5	22	23	20
3	5	7	4	Oct. 3	21	7	17	29	5
5	2	11	1	18	14	9	12	V Lacertæ	
6	23	14	21	WZ Cygni		11	7	(−1	17)
8	20	18	17	Minimum		13	2	Sept. 3	22
10	16	22	13	Period 14h		14	21	8	21
12	13	26	10	Sept. 1	7	16	16	13	21
14	10	30	6	3	15	18	11	18	21
16	7	η Aquilae		5	23	20	6	23	20
18	4	(−2	6)	8	7	22	1	28	20
20	0	Sept. 7	23	10	15	23	20	Oct. 3	19
21	21	15	3	12	23	25	15	8	19
23	18	22	7	15	8	27	10	13	19
25	15	29	11	17	16	29	5	18	18
27	11	Oct. 6	16	20	0	31	0	23	18
29	8	13	20	22	8			28	18
Oct. 1	5	21	0	24	16	VY Cygni			
3	2	28	4	27	0	(−2	2)	88.1906	
4	23	S Sagittae		29	8	Sept. 5	10	Lacertæ	
6	19	(−3	10)	Oct. 1	16	13	7	Sept. 1	19
8	16	Sept. 8	17	4	1	21	3	7	6
10	13	17	2	6	9	29	0	12	16
12	10	25	11	8	17	Oct. 6	20	8	3
14	7	Oct. 3	20	11	1	14	17	23	13
16	3	12	6	13	9	22	14	29	0
18	0	20	15	15	17	30	10	Oct. 4	11
19	21	29	0	18	1	VZ Cygni		9	21
21	18	V Vulpeculae		20	9	(−2	12)	15	8
23	15	Minimum		22	17	(−3	6)	20	18
25	11	Sept. 28	10	25	2	Sept. 4	19	26	5
27	8	X Cygni		27	10	9	13	31	15
29	5	(−6	19)	29	18	15	13		
31	2	Sept. 7	13	RV Capricorni		19	6		
U Vulpeculae		23	22	Period 10h.7		24	6		
(−2	3)	Oct. 10	8	Sept. 1	22	29	0		
Sept. 4	5	26	17	3	17				

New Variable Stars 29-32, 1907 Aurigæ.—These are announced by Dr. E. Silbernagel, of Munich, in *A. N.* 4175 and their positions are as follows:

	α 1855	δ 1855	α 1900	δ 1900
	h m s	° ′	h m s	° ′
29.1907	5 40 00	+31 37.8	5 42 55	+31 38.8
30.1907	5 13 32	+33 20.1	5 16 29	+33 22.9
31.1907	6 02 12	+47 47.7	6 05 36	+47 47.4
32.1907	6 04 00	+46 49.2	6 07 21	+46 49.6

No. 29.1907 on plates taken March 29, and September 23, 1901 and March 16, 1907 appears of about 9.5 magnitude, while on a plate obtained October 22, 1906 it is of 14.5 magnitude.

No. 30.1907 was of about 12 or 12.5 magnitude on plates obtained October 22, 1907 and March 16, 1907, but was invisible on a plate exposed $3^h\ 20^m$ September 23, 1901 and so must have been below 14.5 magnitude.

No. 31. 1907 was of magnitude 9.0 October 13, 1901 but on a plate exposed January 15, 1903, was invisible ($<14.^m5$).

No. 32.1907 on January 15, 1903 was of about 12^m but on October 13, 1901 was below 14.5^m. Charts are given showing the positions of the variables relative to neighboring stars.

New Variable 33.1907, Persei.—This is announced in *A. N.* 4177 by A. Bemporad of Catania. The star is in the position of BD. + 49° 499 (9.5^m)

α 1855	δ 1855	α 1900	δ 1900
$1^h\ 46^m\ 43.^s1$	+49° 46.′2	$1^h\ 49^m\ 34.^s4$	+49° 59.′6

On a photograph taken December 2, 1902 at Catania the star appears of magnitude 11.1 and again on March 30, 1907 of magnitude 10.7.

New Variables 34 to 47.1907.—These announced in the Harvard College Observatory Circular No. 127, having there the numbers 2891—2904.

No.		R.A. 1900	Dec. 1900	Brightness	
		h m s	° ′		
34.1907	Persei	2 00 48	+57 58.2	9.3	10.0
35 "	Persei	2 15 05	+56 08.8	9.2	10.1
36 "	Cassiop.	2 19 51	+59 00.6	10.6	11.2
37 "	Cassiop.	2 37 38	+65 18.6	8.2	9.0
38 "	Cassiop.	2 44 24	+62 22.4	8.8	9.4
39 "	Camelop.	3 46 09	+58 21.6	9.0	10.0
40 "	Camelop.	3 56 43	+58 22.9	8.6	9.2
41 "	Camelop.	4 21 28	+64 13.5	9.5	10.5
42 "	Urs. Maj.	11 12 22	+45 44.2	8.2	9.0
43 "	Draconis	11 32 14	+67 53.2	9.0	9.7
44 "	Urs. Maj.	11 35 24	+52 33.9	9.5	10.5
45 "	Draconis	12 12 48	+70 04.0	8.8	9.6
46 "	Urs. Maj.	12 16 12	+64 14.0	8.3	9.0
47 "	Draconis	12 21 49	+69 14.4	9.4	10.0

Notes.—37.1907 Apparently of the Algol Type. 38.1907—Apparently of the Algol Type. 39.1907—Period evidently short. 43.1907—Period evidently very short. 44.1907—Apparently of the Algol Type.

New Variable 48.1907 Aquarii.—In *A. N.* 4177 Rev. Thomas D. Anderson of Northrig, Haddington, Scotland, calls attention to a star not in the BD., for which the position for 1855 is approximately

$$\alpha = 20^h\ 58^m\ 26^s \qquad \delta = -0°\ 48'.$$

He gives the following estimates of its brightness:

Nov. 18, 1906, $<11.^m2$; Apr. 17, 1907, $10.^m7$; May 13, $9.^m9$.

New Variable 50.1907 Ophiuchi. In *A.N.* 4184 Rev. T. D. Anderson announces the variability of a star which is not in the BD. and whose approximate position for 1855 is

R.A. = $16^h\ 50^m\ 19^s$ Dec. = $-2°\ 32'$

On April 21 it was of magnitude 8.8; May 13, 9.3; and on May 20, 9.6.

New Variables 51-65. 1907.—These are announced in Harvard Observatory Circular No. 129, and are there given the numbers 2905-2919.

Designation		R.A. 1900 h m s	Dec. ° ′	Brightness
51.1907	Andromedæ	1 27 34	+46 00.4	9.2 —<11.5
52 "	Ophiuchi	17 28 50	− 1 00.4	10.0 — 11.1
53 "	Ophiuchi	17 34 22	+ 1 39.8	10.0 — 11.0
54 "	Ophiuchi	17 51 25	+ 3 24.1	9.7 —<12.0
55 "	Serpentis	18 04 07	−15 33.8	8.5 — 10.0
56 "	Scuti	18 18 04	−13 42.6	9.3 — 10.4
57 "	Scuti	18 25 41	−13 10.9	9.5 — 11.0
58 "	Scuti	18 32 36	− 8 27.3	8.9 — 10.2
59 "	Scuti	18 36 40	− 4 12.6	9.1 — 10.2
60 "	Ophiuchi	18 36 49	+ 6 19.6	10.6 — 11.4
61 "	Scuti	18 37 36	− 5 55.9	9.0 — 10.3
62 "	Scuti	18 43 40	−10 21.0	8.9 — 9.8
63 "	Aquilæ	18 59 35	+ 1 09.1	8.8 — 10.5
64 "	Aquilæ	19 03 10	+ 1 08.7	7.6 — 9.0
65 "	Cassiopeiæ	23 02 53	+58 01.0	9.2 — 10.2

Notes.—51.1907 Max. = 2412486 + 337 E. 52.1907—Period probably about one day or a division thereof. 53.1907—Period short. 54.1907 Max. 2414862 +216 E. 55.1907—Algol Type. Period $14^d.15$. 56.1907—Apparently of the Algol Type. 57.1907—Period short. 58.1907—Period not greater than ten days, and it may be much less. 59.1907—Period short. 60.1907—The period may be irregular. 61.1907—The period apparently does not exceed four days. 63.1907—Max. = 2412685.63 + $17.^d132$ E. The star probably remains bright for at least two days. 64.1907—Max. = 2411873.865 + 13.75 E. 65.1907—Period about five days.

New Elements of R Trianguli.—In *A.N.* 4186 Mr. M. Luizet gives the following elements depending upon observations in the years 1892-1906. The observations include fourteen maxima and six minima.

Max. 1890 Sept. 26.0 = 2411637.0
Min. 1890 May 25.2 = 2411513.2 } + $266^d.84$ E.

New Elements of U Vulpeculæ.—In *A. N.* 4181 Mr. M. Luizet of Lyons, France, gives a long series of observations of this variable and determines new elements from his own observations combined with those of Mr. Yendell and Messrs Müller and Kempf.

Max. = 2414200.259 (Paris M.T.) + $7.^d98950$ E
or 1897 Oct. $2^d\ 6^h\ 13^m$ " " + $7^d\ 23^h\ 44^m\ 53^s$ E.

Min. = 2414196.795 (Paris M.T. +7.98950 E
or 1877 Sept. $28^d\ 19^h\ 05^m$ " " + $7^d\ 23^h\ 44^m\ 53^s$ E.

He gives also a light curve showing that the light of U Vulpeculae increases regularly for 3.0 days and decreases for about 5.0 days.

GENERAL NOTES.

Professor David P. Todd has been making a study of the central eclipse of the Sun for April 13, 1912. The part of the eclipse visible from land will be of very brief duration, a few seconds of time only. The central line runs from Oporto, Portugal to Oviedo, Spain. The line of that part of the eclipse that is annular will later pass near to Paris. It is said that the change from the total phase to the annular will take place in the Bay of Biscay, if the computers have made no errors in the choice or the use of the proper data for the calculation. Professor Todd thinks it best to try to observe this eclipse though the time of totality be so small.

Degrees Conferred. At the recent commencement exercises of the University of Illinois, among the degrees conferred was that of doctor of laws upon Professor George C. Comstock, Director of Washburn Observatory, University of Wisconsin. The following week he was honored by the doctor of science from the University of Michigan.

Dr. Frank W. Reed of the University of Virginia has been appointed instructor of astronomy in the University of Illinois.

Burnham's General Catalogue. Among the articles of this number of special interest is Mr. Aitken's review of S. W. Burnham's splendid new catalogue of double stars.

It is a matter of regret successively to Professor Hale and Professor Frost, directors, that they were unable to get from the University of Chicago means for issuing the book as one of the Publications of the Yerkes Observatory. The work was gotten out by the Carnegie Institution, free distribution being possible only to the few institutions which receive all their publications. Yerkes Observatory has no copies for distribution or on sale so any desiring such should apply to the Carnegie Institution, Washington, D. C., Price $14.

Henry Norris Russell has prepared a paper on the probable distance of the constellation of Orion. He thinks that nearly all the bright stars in Orion are roughly at about the same distance from us. These stars are similar in their spectra and their proper motions. Their proper motions being small indicate a small parallax which means their distances are great. The fact that many of the stars are double, and that probably some are physical binaries, showing motion in rotation, more or less small, it is possible to find the relation between the parallax and the mass of such systems, the distance between the components and the ratio of their motion. Such data when applied to several systems ought to give an average result of value. If we consider the orbits of two of the binaries already determined, their average is about ten times that of our Sun. This gives a mean parallax of 0″.005, which makes those stars at a distance of 600 light years. This interesting and difficult piece of work might well engage the attention of observers competent to do the work as a part of the larger question which concerns the size of the universe.

Alexander Larson of Chicago, Illinois, has a method of photographing lightning with a moving camera that promises well. We have received a reprint of pages 119-127 from the Smithsonian report of 1905 which shows the study of lightning flashes which has been prosecuted to some extent by aid of the Hodgkins fund of the Smithsonian Institution. The article gives illustrations of the photographic instrument used, and some fine plates of flashes taken by it.

Auhagen's Demonstration. The writer is not aware of the existence elsewhere of the following demonstration of the proposition that if A, B, C, are the angles of a plane triangle, or if

$$A+B+C=180^\circ$$

then

$$\sin 2A+\sin 2B+\sin 2C$$

is never greater than $\sin A+\sin B+\sin C$.

For

$$\frac{\sin 2A+\sin 2B+\sin 2C}{\sin A+\sin B+\sin C}=\frac{4.\sin A\sin B\sin C}{4.\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}}=8.\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}.$$

Now let a, b, c, the three sides of the triangle, R and r the radius of the circumscribed and inscribed circle, respectively, then

$$a+b+c=2R(\sin A+\sin B+\sin C)=2r(\operatorname{cotg}\frac{A}{2}+\operatorname{cotg}\frac{B}{2}+\operatorname{cotg}\frac{C}{2})$$

$$4R\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}=r\operatorname{cotg}\frac{A}{2}\operatorname{cotg}\frac{B}{2}\operatorname{cotg}\frac{C}{2}$$

or

$$8\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}=\frac{2r}{R}=\frac{2Rr}{R^2}$$

But

$$d^2=R^2-2Rr$$

is the square of the distance of the centers of the two circles and therefore always a positive quantity which vanishes only in the case of an equilateral triangle, where $r=\frac{R}{2}$.

Thus the maximum value of

$$8\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}$$

is unity, which proves the proposition.

WM. AUHAGEN.

Washington, D. C., June 6, 1907.

The Scale of Observatory Work in the Future. The great astronomers of the world are most interested in, and think most about, the great themes belonging to the science. That fact was clearly shown in the late and last work of William Herschel. Above all else, he wanted to know how large the universe is.

The great astronomers of Germany years ago, saw how needful it was to

have a general, visual survey of the whole starry heavens, and they have diligently and successfully worked at it since.

When photography came to the front as a means of securing astronomical data, nothing less than a photographic survey of the whole heavens seemed to satisfy the distinguished astronomers of France and many from other countries joined them and the most wonderful piece of work of its kind known to science was undertaken and it is now nearing completion. Numerous instances of this kind will occur to any one familiar with practical work in astronomy through all its history. The idea of a large plan of work and a large purpose in it are most natural things in the world to occupy the attention and the deeply searching thought of a scholarly astronomer.

We do not wonder that Professor E. C. Pickering at the last meeting of the Astronomical and Astrophysical Society of America, in New York, as its president, should say that there should be coöperation of astronomers to carry on some great routine investigation too large to be done by a single observatory and that the old men and the new men should have acquaintance. These are two very important things in the future progress of astronomy, for they are exactly in line with all that has been suggested or may be possible in united wisdom and united effort.

"Northern Lights." Those who happened to be looking at the sky last evening about nine o'clock had an opportunity of seeing a very rare display of what is known as "Northern Lights." It was first noticed about 8:45 and did not entirely disappear till half past nine. It consisted of an arch of rather bright white light extending from horizon to horizon from east to west across the sky. Its direction was from a little south of east to a little north of west. The belt of light was some five or six degrees wide directly over head, and narrowed somewhat by perspective towards the horizon. When first seen its border was quite sharp and distinct. Its southern edge was about five degrees north of the star Altair in the constellation Aquila. It touched and partly covered the semicircle of stars in the Northern Crown, and was about ten degrees north of Arcturus. This will sufficiently locate its position in the heavens for those who are acquainted with the constellations.

When first seen there was a distinct and rapid billowy motion from east to west in the upper part of the arch and occasionally were seen rifts in the belt of light cutting across it diagonally from southeast to northwest. Slowly the whole arch drifted towards the south, widening at length to about twice its original breadth and growing gradually fainter till it disappeared about 9:30. In its shifting towards the south it came at last to be central over Altair, and was clear of the Crown for the most part, its northern edge barely touching it. Once about 9:20 there was a reappearance of the crests of light with intervening rifts of dark in the upper part, for a few seconds.

So far as I know there has never been noticed exactly such a peculiar display of Northern Lights except on one occasion and that was some three years ago. The writer of this saw it while on his vacation in the mountains of New Hampshire. It was noticed and described by others in that state and in Maine, also in the northern part of New York and so on west across the Mississippi valley even as far as the Rocky Mountains. It will be interesting to note if this one had so wide an extension.

A. B. Hervey.

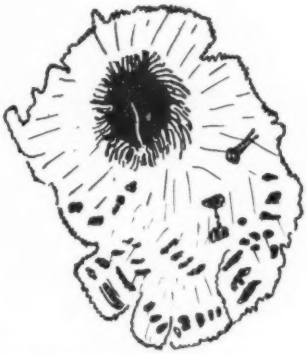
"*Daily Times*" July 4.
Bath, Maine.

Professor Todd's Expedition. "El Comercio", June 7, Lima, Peru, S. A., contains an extended notice of the arrival there of Professor Todd of Amherst Observatory, with the expedition, to observe the partial solar eclipse of July 10, and also to photograph Mars at opposition. Iquique, Chile, seems to have been selected by Professor Todd as the best place for photographing the eclipse. He may return later to some lofty site near Lima to photograph Mars.

This expedition is sent out through the generous support of Professor Percival Lowell, who is making simultaneous photographs at Flagstaff, Arizona,

Mention is made of the many solar eclipses which Professor Todd has observed in various parts of this world. His astronomical writings as well as those of Mrs. Todd, who accompanies him, are quite fully noticed.

Great Sunspots. Dr. E.D. Roe, Jr., of Syracuse University, Syracuse, N. Y. favors us with drawings of large sunspots which have interested him especially during this year and last.



July 30, 1906, 4 P. M.
Power 335.

February 15, 1907, 12:30 P. M.
Power 83.

He says the great spot of July 1906 developed from five small pores which he observed on the 27th at 8:30 A. M. On the 28th day of the month, there was

June 16, 1907, 1 P. M. | June 15, 1907, 11:05 A. M. | June 14, 1907, 8:30 A. M. | June 13, 1907, 9 A. M.

Power 83.

a considerable disturbance in the place of the pores. On the 29th the spot was forming, but cloudiness prevented a good view of it. On the 30th the conditions were better and a drawing was made.

Mr. Roe observed the great spot of February last, first on the 7th; his drawing is for the 15th, and he continued watching it until March 4. The drawings also show a series of views of the beautiful sunspot of June last, that so many

June 1, 1907, 1:15 P. M.,
167 Diameters.

observers have spoken of in the scientific periodicals since that time. Mr. Roe adds his testimony to the same effect.

Drawings of sunspots when made by an expert show more detail than any photograph can get however carefully it may be manipulated.

Miscellaneous Computers: U. S. Naval Observatory. On or about September 11, 1907, an examination will be held by the Civil Service Commission to secure eligibles from which to make certification to fill three vacancies in the position of miscellaneous computer and one vacancy in the position of assistant, $1,000 per annum, Naval Observatory, Washington, D. C. Miscellaneous computers are paid by the hour and earn from $900 to $1100 per annum. Promotions are made from this grade without further examination to the grades of assistant at $1,200 per annum, as vacancies occur.

As an insufficient number of eligibles were secured as the result of the last four examinations to meet the needs of the service, qualified persons are urged to enter this examination.

Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for full information concerning the examination.

Applicants can be examined at various places throughout the United States.

The Auroral Arch of August, 1903. You will recall that, in 1903, I wrote you an account of the remarkable phenomenon witnessed by myself and others, in the month of August, from our location at Cranberry Lake, in the Adirondack wilderness, the auroral arch, springing up in the east, and, with a breadth of several moon's diameters, extending practically through the zenith and across the entire sky, where it steadily sustained itself for perhaps twenty

minutes. It appears to have been a very extensive affair, inasmuch as reports concerning it were received from as far west as Montana, and as far east as Maine.

I was reminded of this a few evenings ago, from my present position on Long Lake in the Adirondacks, when there was a remarkable exhibition of Aurora Borealis, as there was that same night, preceding the rising of the auroral arch: but nothing of the kind has yet developed this summer.

I did not suppose that I had ever seen a similar phenomenon, and believed that few of mankind had ever witnessed its like. But this week I was looking over some of the journals of my boyhood, when I was surprised to find that, under date of September 7, 1871, I had made the following record: "In the evening an exceedingly bright streak of light reached from as far east as we could see, clear over our heads, towards the west, quite a distance. It was the most remarkable of the northern lights that I ever saw. It was quite wide. We all saw it."

This was written from my home in Rochester, N. Y., where the view was probably more or less obstructed by buildings and shade trees. It was evidently the very same kind of a phenomenon as that recorded by me in 1903, but forgotten, as so many events and experiences of childhood are; and the brief description tallies closely with what was said of the arch of 1903, even to the extent from east to west, the passing through the zenith, and the width of the band.

It would be interesting to know whether any historical record was made of the event of 1871, and, if such phenomena occur again, the full particulars concerning the same ought promptly to be made public.

FREDERIC CAMPBELL.

President Department of Astronomy,
Brooklyn Institute.

The Planet Mars. The planet Mars is again passing a favorable opposition which occurs only once in about fifteen years. Why the opposition at such times is called favorable is perhaps generally understood by our readers, for we presume they know that the orbits of Mars and the Earth are of such elliptical shape that when Mars is as near the Sun as possible and the Earth is as far away as possible, the two planets are as near together as possible when both are in the same direction from the Sun.

At such times observers can see very much more than at others because of the comparative nearness of the planet. In 1877 the tiny satellites of the planet were discovered by Professor Hall. At such times the canals and other surface markings of the planet are best seen.

At the present time it is a little early to get the results of the work done because observers are still at work. Because the planet is so far south in declination, astronomers of the middle northern latitudes have a poor chance to do much, yet some of them who were not satisfied to let so good an opportunity go by without improving it have gone to South America for that purpose.

Percival Lowell who has done more thorough work on the planet Mars probably than any other man living has fitted out and sent an expedition at his own expense to Chile, South America to observe the planet.

It is reported that Professor Todd, who is in charge of the expedition, has been successful in photographing the Canals. Mr. Lowell himself is so thoroughly acquainted with the markings of the planet's surface that he detects the changes that take place in them, because his drawings and notes are so full and complete from years of study that he has now a great advantage over observers generally in this field.

The literature about Mars in the current magazines is, some of it fanciful,

some funny, some very mysterious, and some of it so wrestling with fact and theory as to show a thirst for more knowledge for a basis from which to learn what the real truth is about many of these things which are yet imperfectly and incompletely seen.

Request for Unpublished Observations of the Variable Star U Geminorun. Mr. J. van der Bilt, astronomer at the observatory Utrecht, Holland, has undertaken the definitive reduction of all available observations of this remarkable variable, and would be very glad to have copies of any unpublished observations, in such detail that they can be reduced by a normal photometric light scale. They may be sent to him directly, address *Maliesingel* 58, *Utrecht*, or if sent to the undersigned they will be transmitted to him.

J. A. PARKHURST.

Yerkes Observatory,
Williams Bay, Wis.

A First Course in Algebra is the title of a text-book in Algebra written by A. H. Wheeler, teacher of mathematics in the English High School at Worcester, Massachusetts, and published by Messrs. Little, Brown and Company, 254 Washington Street, Boston, pp. 653, list price half leather $1.15.

This new book in algebra is intended for beginners, and very plainly bears the marks of a teacher of algebra in all its preparation. One of the best things in it that will get the attention of the practical teacher of this branch is the large number of mental and written exercises connected with all the various themes. The author has kept in mind very well the need of the beginner in this regard. In the free use of mental exercises the teacher is able to gain a more exact knowledge of the progress of the student than he can possibly know from written tests or examinations though they are frequently given.

The exercises are chosen to illustrate, in many instances, the applications of the simple principles of algebra to problems of physics and to others of modern interest.

The free use of graphs is also a modern idea in teaching algebra. Apparently the author has been careful to give accurate figures and to use such only as will illustrate what he wishes to show better than can be done by ordinary language.

Another good feature is the system of checks in algebraic work throughout the book. Every teacher knows how easily a good student is liable to fall into the habit of working exercises to get a given result, without depending enough on himself and the accuracy of his work to feel assured in his own mind that his result must be right. This vital point can not be emphasized too strongly, because it has to do with a habit that will affect the student's life possibly for all time very powerfully.

The omission of "answers" to the problems will put on the teacher some responsibility to know that students are right in method and result. This, we think is as it ought to be, to say nothing of the influence of known results on the student's mind while he is at work.

The publishers have done their part plainly, very neatly and well.

This new book impresses us very favorably.

Fauth's Moon in Modern Astronomy is a summary of twenty years of selenographic work and a study of recent problems relating to the Moon by Philip Fauth. It is a translation from the German by Joseph McCabe, with an introduction by J. Ellard Gore. It is printed on fine plate paper, and has sixty-

seven illustrations. It is published by Messrs. A. Owen and Co., 28 Regent Street London, England. Price 10 shillings.

As one reads the introduction to this new book; he wonders at the mass of facts crowded into ten pages which Mr. Gore there presents. Yet one who knows of Mr. Gore's writing on live astronomical themes has learned to expect from his pen always much that is interesting, up to date, and practically useful to all readers.

The variety of detail that he has at command about the Moon makes this part of the book an excellent review of this celestial body for anyone to read or to have for reference.

The writer of this book gives an account of the features visible on the Moon's surface derived from his own observations made during the last twenty years with refracting telescopes with 6½ or 7 inches aperture. He discusses the "meteoric theory" of the formation of the lunar craters and mountains believing that a bombardment of the Moon's surface by large meteors would be quite inadequate to produce such enormous ring mountains as we see on the lunar surface.

Another good feature is the strong point made by Mr. Fauth in this connection couched in the question, How could the Earth have escaped a similar bombardment? True it is, no such evidence as the Moon presents is found anywhere on the Earth's surface, yet there is some difference between the two bodies in regard to size and the possible density of atmosphere. What effect a very dense atmosphere might have if full of large meteors is not easily determined.

Mr. Fauth's views of these walled plains or ring mountains seem to us very natural and well considered. They are given somewhat in detail, regarding many of the notable ones with the methods of study used by him for a long time. In this work incidentally he refers to the photographic methods and the older way of making drawings or the purpose of an accurate study of lunar details. He thinks photography has its uses in these records especially in relating objects correctly, but holds that this method has not been so successful as in other branches of astronomy, in showing details, on account of the lack of sharpness of definition. In this, we think, Mr. Fauth is right, especially if comparison be made between the work done by experts in drawing as compared with good photographs of modern make.

It will surprise some readers of this book that Mr. Fauth holds that the Moon is covered with a thick layer of ice, because, among other reasons, the surface of the Moon is at a temperature that must be very low. Many astronomers hesitate to accept this, as they do some of his views in regard to the volcanic theory of the origin of some lunar surface formations. But on the other hand there is some authority of worth that holds to the same views essentially as those advanced by Mr. Fauth. Students of the Moon will be glad to know that the author has in preparation a map of the Moon on a large scale, which Mr. Gore says: "will show an enormous amount of detail, and it will certainly, I think, be more reliable than any photograph taken. From this elaborate work, any suspected changes in topography in future years may be either verified or disproved."

In looking over the illustrations given in this book we must say that Mr. Gore has apparently good ground for making so strong a statement as that just given. If one turns to the full page plate of Copernicus, facing page 117, he will see an enormous amount of detail, put in clear, definite penciling so that nothing intended to be shown is left in doubt. That is a beautiful and admirable piece of work of its kind. It at once reminds one of that classic piece of work done

on a great sunspot by our own distinguished Langley years ago that has since adorned the pages of scores of popular books and text-books on astronomy, and it still stands unrivalled of its kind.

This book is divided into six chapters covering 135 pages, the topics treated in these chapters are, a historical survey, appearance and reality, light and color, the ring mountains, the remaining elevations and rills, and some conclusions. In that final chapter is a summary of the views of the things of which the author cares to speak, and it is a very creditable setting for some of the interesting topics in lunar study which many readers will thoroughly appreciate.

We welcome this new book as a very useful contribution to the literature of the Moon that will have lasting value. We hope soon to see this new map of the Moon which Mr. Fauth is now making.

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